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CONTENT

AGRICULTURAL SCIENCES

Pecheniuk V., Latoshkin Ye.
INNOVATIVE PHYTO-TECHNOLOGIES FOR THE CULTIVATION OF ENERGY AND NICHES CROPS IN THE FOREST-STEPPE REGION OF UKRAINE.....4

Turko V.M., Moroz V.V., Turko M. V.
AGROPHYSICAL PROPERTIES OF RECULTIVATED SOILS AND THEIR CHANGES UNDER THE INFLUENCE OF FOREST PLANTATIONS OF VARIOUS SPECIES COMPOSITION.....11

BIOLOGICAL SCIENCES

Balcevich N., Vekariya J.L., Babariya D.J., Kozlov SN., Vdovichenko VP.
PHARMACOGENETICS OF ANTIPLATELET THERAPY: A PERSONALIZED APPROACH TO THE SELECTION OF P2Y12 RECEPTOR INHIBITORS (REVIEW).....17

Elgun I.A., Gurbanova G.V., Gulmammadova A.E.
CURRENT STATUS OF FLIES THAT ARE POTENTIAL VECTORS OF LEISHMANIOSIS IN BARDA REGION.....22

Nuray A. Leyla K. Aygun N.
FRESHWATER ANGELFISH (*PTEROPHYLLUM SCALARE*) AS A MODEL ORGANISM: BIOLOGY AND ITS USE IN SCIENTIFIC RESEARCH 24

CHEMICAL SCIENCES

Iryna K., Yurii K.
SYNTHESIS OF ADAMANTYL AMIDOALKYL AGENTS AND NITROGEN HETEROCYCLES ON THEIR BASIS.....27

ECONOMIC SCIENCES

Mamonov K., Prunenko D., Frolov S., Frolov V.
MEASURES TO ENHANCE THE INVESTMENT APPEAL OF CONSTRUCTION COMPANIES 32

Jakhongirov K.A.
ECONOMIC EFFICIENCY AND DEVELOPMENT TRENDS OF EDUCATIONAL TOURISM IN THE CONTEXT OF GLOBALIZATION 37

Kerimova M.H., Babakishiyeva S.F., Yusubova Sh.A., Garayeva Ye.V.
MODERN APPROACHES AND TRENDS IN FINANCIAL MANAGEMENT OF ENTERPRISES IN THE DIGITAL ECONOMY 42

Murotov Sh.A.
THE ROLE OF ARTIFICIAL INTELLIGENCE IN IMPROVING THE QUALITY OF SERVICE IN THE FIELD OF TOURISM.....49

Mamurov Sa.I.
INCREASING THE EFFICIENCY OF THE INFORMATION SYSTEM IN UZBEKISTAN'S TOURISM ACTIVITIES THROUGH PIMS ANALYSIS 55

MEDICAL SCIENCES

Khanmirzayev F. I., Janahmadova Sh. N., Akbarova A. A., Aliyeva G. O., Abbasova Y. C., Bandalizada G. S., Bakhshiyeva S. H.
EFFICACY OF CURRENT DRUGS AGAINST SOIL-TRANSMITTED HELMINTHS.....61

Andreea Monica FILIP, Dorina STAN, Puşica ZAINEA,Adrian DRAGAN, Dragoş F. VOICU.
LEMIERRE SYNDROME COMPLICATED BY CERVICOFACIAL NECROTIZING INFECTION – CASE REPORT.....65

Moldotashev I.K., Nazarov A.K., Sorokin A.A.
UNIVERSAL PROGNOSTIC ROLE OF LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN EUROSCORE II, STS, AND MAGGIC MODELS.....69

PEDAGOGICAL SCIENCES

Firadun I., Gulara A., Sevinj A.
DIRECTIONS FOR REGULATING THE ENVIRONMENT THAT AFFECT THE DEVELOPMENT OF STUDENTS' SKILLS ADEQUATE TO THE CHALLENGES OF MODERN SOCIETY 75

Liao Xi.D., Kosherbayeva A.N., Kalimoldayeva A.K., Abilmazhinova O.S.
A COMPARATIVE STUDY ON MENTAL HEALTH AMONG UNIVERSITY STUDENTS IN CHINA AND KAZAKHSTAN: INTEGRATED INTERVENTION OF TRADITIONAL PHILOSOPHIES AND POSITIVE PSYCHOLOGY 80

Manana M.
SOME METHODOLOGICAL ISSUES FOR FOREIGN LANGUAGE TEACHERSS 83

Parmankulova D., Rozaliya Sh.
INTEGRATING CRITICAL THINKING INTO PUBLIC SPEAKING TRAINING FOR FUTURE DIPLOMATS AND IR SPECIALISTS 89

Sandybay A.A., Kalimoldayeva A.K.
FORMATION OF ENTREPRENEURIAL SKILLS AMONG SENIOR SCHOOL STUDENTS: INTERNATIONAL EXPERIENCE AND IMPLEMENTATION IN THE CONTEXT OF KAZAKHSTAN 94

Zhumabay M., Kalimoldayeva A.K., Abilmazhinova Or.S.
FORMS AND METHODS OF MANAGING THE EDUCATIONAL PROCESS IN MODERN SCHOOLS BASED ON DIGITAL MONITORING 96

Azadaliyeva Sh.M.
THE NEGATİVE IMPACT OF A DYSFUNCTİONAL FAMİLY ON ADOLESCENCE: CAUSES OF THE EMERGENCE OF DEVİANT BEHAVİOUR 103

PSYCHOLOGICAL SCIENCES

Eyyubova R.
MAİN DİRECTİONS AND MODERN APPROACHES OF PSYCHOLOGİCAL SCİENCE 106

TECHNICAL SCIENCES

Kiyalbay S., Sultan Ye.
A STUDY OF THE INFLUENCE OF TRAFFIC INTENSITY ON THE DETERMINATION OF THE LOCATION OF SERVICE FACILITIES IN THE ROADSIDE ZONE OF MOTOR ROADS 110

AGRICULTURAL SCIENCES

INNOVATIVE PHYTO-TECHNOLOGIES FOR THE CULTIVATION OF ENERGY AND NICHES CROPS IN THE FOREST-STEPPE REGION OF UKRAINE

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Abstract

This article is devoted to a comprehensive analysis and justification of innovative approaches to the cultivation of energy poplar and the seed production of root chicory – two strategically important areas of modern agricultural production. The subject of the study is the patterns of the plants' morphophysiological development, the dynamics of biomass accumulation and the formation of seed productivity under the influence of technological factors in the transitional climate of the Forest-Steppe zone.

The aim of the work was to develop a comprehensive resource-saving system that would enable agricultural enterprises not only to adapt to global climate aridification but also to achieve a high level of energy self-sufficiency and financial diversification.

The research methodology is based on the integration of field experimental data obtained at representative locations in the Right-Bank and Western Forest-Steppe with modern methods of physiological and energy monitoring. The authors have employed a systematic approach to the evaluation of phytotechnologies, which includes morphometric analysis of growth processes, determination of photosynthetic activity parameters, and calculation of energy balances.

It has been established that, under Forest-Steppe conditions, traditional agriculture requires supplementation with phyto-energy clusters. The article provides a detailed account of the biological phenomenon of poplar's ultra-rapid growth. It has been demonstrated that its morphophysiological advantage lies in high stomatal conductance and the capacity for prolonged cambial activity. Particular attention is paid to plantation establishment technology, where the feasibility of using elongated cuttings as a means of ensuring survival rates under conditions of spring moisture deficit is substantiated. The study analyses the scientific foundations of chicory seed production. In particular, it is noted that the achievement of maximum seed productivity directly depends on the of soil cultivation systems. It has been established that non-plough (chisel) cultivation to a depth of 25–27 cm promotes better root architecture of the mother plant and prevents the lodging of flower stalks. An energy audit was carried out, which confirmed that energy poplar demonstrates an impressive balance: up to 15 units of clean biofuel are produced for every unit of energy consumed. This allows poplar wood chips to be used for the farm's operational needs, in particular for the energy-intensive process of drying chicory seeds. A positive impact of poplar plantations on soil fertility has also been recorded.

The article sets out practical recommendations for agricultural management, including algorithms for selecting land plots based on agrochemical indicators, calculating the logistics reach for biofuel, and methods for diversifying income by combining long-term energy projects with highly profitable niche seed production. The article proposes a scientifically grounded model for the transition to adaptive and resource-efficient agricultural production, which is of great importance for the sustainable development of Ukraine's agricultural sector.

Keywords: energy poplar, chicory, seed production, resource efficiency, Forest-Steppe, energy audit, biomass.

The current state of Ukraine's agro-industrial complex is characterised by the need for rapid adaptation to global challenges: energy shortages, climate aridification and the need to diversify agricultural production. In the context of the 'Green Transition', the cultivation of energy crops, particularly poplar, as a source of renewable biomass, is becoming particularly relevant. At the same time, to ensure the economic sustainability of farms in the Forest-Steppe, it is important to develop niche crop production, in which root chicory plays a leading role.

Despite their significant potential, the efficiency of growing these crops in the Right-Bank and Western Forest-Steppe zones is hampered by the instability of the hydrothermal regime and the need to optimise cultivation techniques. Detailed study is required into energy-saving soil cultivation, the rational use of crop spatial resources, and the introduction of remote monitoring methods to control the condition of agrophytocenoses. Thus, the scientific justification of innovative phytotechnologies based on resource efficiency and environmental safety is a priority task for modern agricultural science.

The aim of the study was to provide a scientific rationale for and develop a comprehensive system of innovative phytotechnologies for the cultivation of energy poplar and the seed production of root chicory,

based on the principles of resource conservation, energy self-sufficiency and environmental adaptability in the changing hydrothermal conditions of the Right-Bank and Western Forest-Steppe of Ukraine.

The methodological basis of the work is a comprehensive systemic analysis of contemporary scientific views on the development of phytopower and niche crop production in the context of climate change. The work is based on the principles of objectivity, relevance and continuity of scientific knowledge, which has enabled the integration of disparate data on woody and herbaceous crops into a single conceptual model of resource conservation.

Appropriate tools were employed to achieve the review's objectives. In particular, the method of theoretical generalisation and systematisation was used to form a comprehensive understanding of the current state and prospects of energy poplar and chicory cultivation. This enabled the classification of global and regional challenges facing modern agricultural management. The method of logical modelling was used to substantiate the concept of energy self-sufficiency for agricultural enterprises through the creation of closed cycles (the use of poplar biomass for energy-intensive seed production processes). The method of abstraction and synthesis enabled the identification of key practical recommendations for the management sector, discarding secondary factors and focusing on strategic development vectors (digitalisation, energy audits, adaptability).

The subject of analytical consideration is innovative phytotechnologies as a dynamic system that is transformed under the influence of environmental (aridisation) and economic (decarbonisation) factors. The synthesis of materials was carried out taking into account the specific soil and climatic conditions of the Forest-Steppe zone, ensuring the regional relevance of the review's conclusions.

Today, the global community is undergoing a radical transformation of socio-economic models. The main driver of these changes is the concept of decarbonisation, enshrined in the Paris Climate Agreement and the 'European Green Deal' strategy. The essence of this challenge lies in the transition from fossil fuels to renewable energy sources, where plant-based biomass plays a special role.

On a global scale, agriculture is ceasing to be merely a provider of calories. It is transforming into a powerful tool for regulating the carbon balance. It is here that the strategic role of energy forest crops, particularly poplars, comes to the fore. Thanks to its high rate of photosynthesis, it acts as a natural 'absorbent' of atmospheric carbon, converting it into solid biomass. At the same time, the global market is driving demand for environmentally friendly niche products, such as inulin, the main source of which is chicory root. This is shaping a new type of economy – a closed-loop bioeconomy, where every hectare of land contributes to energy self-sufficiency and the nation's health.

For Ukraine, the issue of introducing bioenergy technologies has shifted from the realm of environmental activism to that of national security. Given the destruction of the traditional energy infrastructure and the instability of global gas and oil markets, the creation of local fuel sources is the only viable option.

Using low-yield land—estimated at millions of hectares—to grow energy poplars allows for the creation of 'green coal mines' right next to the consumer. This minimises logistics costs and creates new jobs in rural areas. At the same time, the development of domestic seed production for niche crops, such as chicory, is a step towards import substitution of high-cost seed material, which is critically important for the sustainability of the agricultural sector.

The forest-steppe zone of Ukraine, particularly its western and right-bank parts, has traditionally been considered the most favourable for intensive agriculture. However, today this region faces an unprecedented challenge – aridisation (gradual desertification). The northward shift of climatic zones means that conditions in the Forest-Steppe are beginning to resemble those of the Northern Steppe: air droughts are becoming more frequent, groundwater levels are falling, and precipitation is largely of a torrential nature.

In this situation, traditional agricultural technologies often prove ineffective. The regional adaptation strategy must be based on two main approaches:

1) Crops with deep root systems – poplar and chicory are able to utilise moisture from deep soil horizons, making them more resilient than cereal crops in conditions of low rainfall.

2) Resource-saving tillage methods – moving away from traditional ploughing in favour of no-till systems helps preserve the soil's capillary structure and store winter moisture.

However, poplar and chicory should not be viewed as isolated entities. They are elements of a single adaptive land-use system. Improvements in poplar plantation technology enable the production of low-cost heat for drying chicory seeds, whilst the development of chicory seed production ensures high profitability through the sale of high-value-added products. Thus, combining these components within a single research project allows for the formation of a holistic vision of modern resource-efficient farming.

Despite the multifunctionality of poplar, its primary focus today is bioenergy. The crop is regarded as a strategic raw material for the production of solid fuel capable of generating heat and electricity, as its calorific value reaches approximately 18.5 GJ/t of dry matter.

Compared to other tree species, poplar has a number of significant advantages for the energy sector:

− exceptional growth rate (depending on the selected clone and environmental conditions, annual growth can exceed 5 metres);

− high productivity – the ability to accumulate significant volumes of biomass in a very short time (on fertile soils, this figure is 18–20 tonnes/ha of dry matter annually);

− optimal chemical composition (the wood is characterised by a high concentration of cellulose with a relatively low lignin content, making it ideal for processing).

The morphophysiological strategy of the poplar is based on the aggressive capture of resources (light, water, carbon dioxide) and their rapid conversion into organic matter.

The poplar (*Populus*) belongs to a group of pioneer species, whose survival strategy lies in colonising open spaces as quickly as possible. One of the key features is a prolonged period of intensive growth during the growing season. Unlike many forest species (such as oak or pine), which have clearly defined growth phases, the poplar is capable of increasing its vegetative mass until the first frosts, provided soil moisture permits.

An important morphological aspect is heterophylly – the presence of different types of leaves on a single tree (early and late). Early leaves emerge from buds and provide initial photosynthesis in spring, whilst late leaves form on new shoots throughout the summer. This creates a 'conveyor belt' of active leaf surface that is constantly renewed and effectively absorbs solar radiation even in the second half of summer.

Although the poplar has a C3 metabolism, it exhibits an extremely high rate of photosynthesis, often approaching that of C4 plants (such as maize). This is achieved through high stomatal conductance. The poplar's stomata remain open for most of the daylight hours, ensuring an uninterrupted supply of CO_2 to the leaf mesophyll. However, the downside of this process is massive transpiration. The poplar functions as a powerful hydraulic pump: to accumulate 1 kg of dry matter, it can consume between 500 and 700 litres of water. This is precisely why, in the southern part of the Forest-Steppe, growth rate correlates directly with the level of the water table and the root system's ability to rapidly reach aquifers.

The poplar has wide-vessel wood with high specific conductivity of the xylem. This allows it to draw up huge volumes of water from the roots to the crown. From a morphological point of view, the poplar is characterised by high cambium activity. The period of cambium cell division in poplar is longer than in most other tree species of the temperate zone. This leads to rapid growth in trunk diameter, which is critically important for energy plantations where the main product is timber itself, rather than fruit or leaves.

The poplar's root system is characterised by exceptional dynamism. In the very first year after planting a cutting, it forms two types of roots:

− superficial (anchor) roots – providing stability and collecting moisture from summer rainfall;

− deep (tap) roots – which penetrate rapidly into the ground (to 2–3 metres or more), a strategic adaptation to the periodic droughts of the Forest-Steppe.

The ability to form adventitious (additional) roots directly from cuttings forms the physiological basis of planting establishment technology. The use of elongated cuttings makes it possible to artificially increase the root absorption surface area within the first few months after planting.

High growth rates are regulated by a powerful hormonal system dominated by auxins and gibberellins. These stimulate cell elongation and apical dominance. This ensures rapid crown development in the upper canopy, enabling the poplar to outcompete weeds and other tree species for light.

Thus, the morphophysiological 'secret' of the poplar lies in the combination of intensive foliage activity, high hydraulic conductivity of the trunk, and the root system's ability to rapidly colonise the soil space. Understanding these processes allows us to refine our techniques: selecting optimal fertilisation and irrigation regimes to provide this biological 'engine' with the necessary fuel – water and mineral elements.

The transition from the biophysical foundations of growth to practical implementation is a stage where agronomic precision must be organically combined with long-term forestry planning. The technology for establishing poplar energy plantations differs fundamentally from traditional afforestation. It is an intensive engineering process in which the tree is treated as an agricultural crop with a multi-year exploitation cycle.

The success of an energy project depends 70% on the quality of work carried out in the first three months. As the plantation is managed in 3–4-year cycles over a quarter of a century, any technical error at the planting stage will only compound over time, leading to thinning of the stands and a loss of profitability.

Poplars are extremely sensitive to competition from weeds and aeration of the root zone. Preparation begins a year before planting:

− Site selection. The best results are achieved on floodplain soils, sites with a high water table (1.5–2.0 m) or fallow land that has not been depleted by intensive farming for a long time.

− Tillage system. Deep autumn ploughing (27–30 cm) or subsoiling is essential. This is critically important for breaking up the 'plough pan', which can become an insurmountable barrier to the poplar's taproots as they strive to reach the water-bearing layers.

− Chemical field disinfection. As the mechanical destruction of perennial root-sprouting weeds (couch grass, thistle) in the rows of young trees is almost impossible, broad-spectrum herbicides must be applied in the autumn. The field must be 'sterile' by the time machinery enters the rows.

In the southern part of the Forest-Steppe, where spring moisture reserves evaporate rapidly, standard 20-centimetre cuttings often end up in a parched soil layer.

− An innovative approach. The use of longer cuttings (25–35 cm) allows them to physically 'reach' stable moisture reserves. This ensures not only higher survival rates (up to 95–98%), but also a stronger start: the greater volume of woody tissue in the cutting serves as a nutrient reservoir for the first shoots.

− Storage and preparation. Cuttings harvested in winter undergo a 'waking' stage – soaking in water for 24–48 hours immediately before planting. This restores cell turgor and triggers the hormonal processes of root formation.

The choice of planting layout is dictated by the available harvesting equipment and the end product (chips or firewood).

− Single-row model. With a row spacing of 2.5–3.0 m and an in-row spacing of 0.5–0.7 m. This layout is versatile; it provides an ideal feeding area for each

tree (approximately 1.5–2.0 m^2) and allows the use of standard tractors for inter-row cultivation.

− Double-row (paired) blocks. Used on an industrial scale, where harvesting is carried out by heavy combine harvesters with special headers. Here, the density can reach 15–18 thousand plants per hectare, which maximises the yield of fine-stemmed biomass.

Technically, planting is carried out as early as possible, as soon as the soil allows machinery access. An important condition is that the cutting must be fully buried: only 2–3 cm (one bud) should remain above the surface. If a 'stem' of greater length is left, it will act as an evaporator, drawing moisture from the cutting faster than the roots can replenish it.

During the first season, poplars grow more slowly than most weeds. Therefore, the method involves mechanical cultivation of the rows 3–4 times. This not only eliminates competitors for light but also acts as 'dry irrigation', breaking the capillaries in the soil and preventing moisture evaporation. Only once the trees reach a height of 1.5–2 metres will they begin to shade the inter-rows themselves, naturally suppressing weeds.

Thus, the technology for establishing a poplar plantation is an investment in an energy asset. Every element (from the depth of ploughing to the length of the cutting) is designed to transition the plant as quickly as possible from the rooting phase to the phase of active utilisation of solar energy.

In the current conditions of Ukraine, research into the mechanisms of reproductive biology in biennial herbaceous plants deserves particular attention. It should be noted that the development of seed productivity in chicory is a complex stage, where the plant's biological potential interacts with agronomic factors during the second year of vegetation.

The process of obtaining high-quality chicory seeds differs fundamentally from the cultivation of marketable root crops. Whilst in the first year we focus on accumulating inulin in the underground part, in the second year the root crop becomes merely an 'energy depot' for a vigorous generative shoot. After planting the mother roots in the soil (or the resumption of growth in winter-sown crops), the primary task is the rapid restoration of the root system. The productivity of the future seed plant is determined during this very period: the sooner the plant forms a rosette of leaves, the more solar energy it will be able to direct towards the development of the flower stalk.

Chicory has a sympodial branching pattern, which gives rise to its main problem – heterocarpy (variation in seed quality):

− the central shoot produces the plumpest and heaviest seeds with the highest germination energy;

− the first- and second-order shoots mature later, and the seeds on them are smaller.

The agronomist's strategy is to maximise the development of the central shoot and the first generation of side branches. This is achieved by regulating the plant's growing space: if the plants are too densely spaced, they compete for light, the shoots become elongated and brittle; if they are too sparsely spaced, the plant begins to branch excessively, which leads to delayed ripening and the loss of a significant portion of the crop due to the shedding of the first fruits.

Chicory is a long-day plant. To transition to bolting and flowering, it requires a certain sum of active temperatures and a day length of over 14 hours. In the conditions of the Right-Bank Forest-Steppe, this period falls in June–July. A lack of moisture at this time leads to the 'drying out' of the buds, which sharply reduces the number of flower heads per plant.

Chicory is a cross-pollinated plant, with insects (bees, bumblebees) playing the main role. This creates a direct link to plant spacing:

− Optimal row spacing ensures free air movement and access for pollinating insects to each flower.

− Overcrowded crops create excessive moisture within the canopy, which promotes the development of fungal diseases (powdery mildew, anthracnose) that affect the inflorescences and cause the seeds to remain underdeveloped.

The seed filling process lasts about 30–40 days after fertilisation. During this period, the plant transfers residual nutrients from the root crop to the seed. This is why the condition of the root crop (its health and size) is crucial. If the soil cultivation technique has kept the root intact and ensured it remains moist, the seeds will be large, with a thousand-seed weight of 1.2–1.5 g.

The formation of chicory seed yield is an art of balancing vegetative growth and generative development. The main aim of scientifically sound technology in the Forest-Steppe is to provide a microclimate and nutrition that yield the maximum number of seeds specifically from the main axes of the inflorescence, ensuring high germination rates and uniformity in future crops.

Chicory is a biennial crop. In the second year, the mother roots are planted to produce seed. The main problem is the uneven ripening of seeds within a single plant (from the central shoot to the third-order shoots).

Traditional ploughing often leads to excessive drying of the topsoil. In the conditions of the Right-Bank Forest-Steppe, non-inversion (chisel) tillage is preferred:

− crop residues are retained on the surface, which reduces soil temperature by 2–3°C;

− capillary moisture rise to the seed zone is improved;

− the rootstock is more firmly anchored in the soil, preventing the flower stalks from 'popping up' and lodging under the weight of the crop.

Optimal plant spacing (45×20 cm) creates a specific phytocenotic effect: the plants support one another, forming a closed 'canopy' that retains moisture within the crop.

An energy audit is not simply a calculation of costs in monetary terms, but an analysis of the energy balance: how many gigajoules (GJ) we invest in the technology (fuel, fertilisers, labour) and how much we receive in return in the form of pure biofuel.

In conventional crop production, we assess profitability through profit, but in energy crop production, the main criterion is the energy efficiency ratio or EROI

(Energy Return on Investment). If for every unit of energy expended we receive fewer than ten units in return, the technology is considered risky or imperfect.

The energy intensity of poplar cultivation is distributed unevenly throughout the plantation's life cycle (20–25 years). The most critical period is the zero cycle (the first year of planting):

1) Direct energy costs (fuel). Ploughing to a depth of 30 cm and repeated cultivation of the interrows account for around 30–35% of total costs in the first year. In the heavy soils of the Forest-Steppe, this figure may rise.

2) Indirect energy (planting material). Energy expended on growing, harvesting, cold storage and transporting cuttings. This is 'advance' energy, accounting for around 25% of the investment.

3) Chemical energy (fertilisers and pesticides). The production of mineral fertilisers (particularly nitrogen-based ones) is an extremely energy-intensive process. The use of 1 kg of nitrogen is equivalent to the consumption of around 80 MJ of energy. Therefore, in resource-saving technologies, we place an emphasis on biologisation and the use of organic residues.

The poplar acts as a natural solar collector. Thanks to its high cellulose content, 1 tonne of dry poplar biomass contains around 18.5–19.0 GJ of internal energy. In the first year, the energy balance is always negative. The plant expends energy on root formation. The breakeven point is reached at the end of the second or the beginning of the third year of growth, when biomass growth begins to offset the costs of establishment. After the first harvest (in the 3rd–4th year), subsequent growth cycles occur without the costs of ploughing and planting. This sharply increases the energy efficiency of the technology, as energy expenditure is now limited to harvesting and transport.

Although chicory is a niche crop, its assessment is also important in the context of seed energy. Drying costs represent the most energy-intensive stage in seed production. Using poplar waste (chips) to power the dryers allows the farm's energy cycle to be closed. Replacing ploughing with chisel ploughing for chicory reduces direct fuel costs by 15–20%, which directly improves the energy balance of the entire seed production process.

Thus, the energy audit demonstrates that establishing poplar plantations in the Forest-Steppe is energy-justified only provided there is high survival rate and intensive growth in the early years. Optimising soil cultivation and utilising the farm's own bio-resources for technological needs (for example, drying chicory) transforms the agricultural enterprise from an energy-dependent consumer into an energy-independent producer.

It is quite important in modern agriculture to take into account the impact of energy and niche crops on soil fertility.

Poplar is a perennial crop with a powerful root system that radically alters the dynamics of fertility. Thanks to the annual shedding of leaves and the decay of fine roots, this crop contributes to the gradual restoration of the humus layer even on low-productivity soils. Poplars are capable of extracting heavy metals and pesticide residues from the soil, which acts as a form of 'biological purification' of the fertile layer. The deep root system loosens compacted soil layers, improving aeration. However, during technical soil removal for exploratory work (for example, for laying irrigation networks), damage to this system can lead to local depletion of the microbiome.

For chicory, the condition of the fertile layer is a critical factor due to the specific nature of root formation. Any compaction caused by surveying or agricultural machinery leads to deformation of the roots, reducing their commercial value (inulin content). Chicory actively consumes potassium and phosphorus. If, during exploratory work, the integrity of the topsoil was compromised or mixing with the podzolic horizon occurred, yields drop sharply due to a deficiency of available forms of micronutrients. For chicory, it is important to preserve the soil's capillary structure. Moving the fertile layer destroys these connections, requiring additional artificial irrigation in the first seasons following reclamation. Chicory is an excellent preceding crop for cereals, as its deep taproot system loosens the plough pan.

A comparative analysis of the impact of poplar and chicory on soil fertility is presented in Table 1

Table 1

Comparative table of the effects of poplar and chicory on soil fertility

Parameters	*Crop*	
	Poplar	*Chicory*
Type of effect	stabilising, long-term	intense, seasonal
Risk of compaction	moderate (strong roots overcome resistance)	high (deformation of the root crop)
Soil layer requirements	deep profile, poor soils acceptable	high humus concentration in the 0–30 cm layer
Effect after reclamation	rapid ecosystem recovery	requires the application of fertilisers to compensate for nutrient leaching

Effective management of an agricultural enterprise in the face of modern challenges requires the integration of technological innovations with traditional methods of maintaining soil fertility. For crops with fundamentally different biology – perennial energy poplar and industrial chicory – recommendations can be categorised into several strategic areas.

The first step for agricultural management is the transition to precise positioning and mapping of fields.

The use of geographic information systems allows humus distribution maps to be overlaid onto technological intervention plans.

For chicory, it is recommended to create digital soil density maps. This allows the manager to adjust sowing rates or tillage depth in advance. For poplars, it is important to integrate data on groundwater levels, as automated moisture monitoring at depths of up to 1.5–2 metres enables the prediction of biomass growth and the planning of harvesting cycles 5–7 years in advance.

The main enemy of soil fertility under intensive management is compaction caused by machinery. It is recommended to implement a controlled traffic system, where all machinery moves strictly along fixed tramlines recorded in on-board computers via an RTK signal. This minimises the area of 'dead zones' in chicory fields, where the root crop cannot develop fully due to over-compaction. For poplar plantations, this approach is critical during harvesting with heavy combine harvesters, so as not to damage the root system, which must ensure the regeneration of shoots in subsequent seasons.

Agricultural management should be based on the principle of targeted application of inputs.

In chicory crops, sensors must be used to determine nitrogen content in real time to prevent excess nitrogen, which stimulates foliage growth at the expense of inulin accumulation in the root.

In the event of exploration or construction work on land designated for energy crops, management must oversee the biological phase of land reclamation. Once the topsoil has been restored, it is recommended to sow green manure crops (such as mustard or oil radish), whose roots 'loosen' the soil disturbed by human activity and restore its microbiological activity before planting the main crop.

Practical management involves the regular use of remote sensing. Analysis of vegetation indices (NDVI) allows the manager to remotely assess the effectiveness of land restoration following soil removal and relocation. If the chicory vegetation index on a particular plot is significantly lower than average, this is a signal to carry out a targeted agrochemical audit or additional loosening. For poplars, monitoring using drones allows for the timely detection of pest outbreaks or moisture deficits, which is particularly important in the first two years after the plantation is established.

Agricultural managers should consider energy poplar as a tool for soil improvement on poor land. It is recommended to allocate plots with disturbed soil structure or low soil quality to poplar, where growing traditional crops (such as chicory) is unprofitable. Such diversification of the land bank allows not only for the production of biofuel but also for the gradual improvement of soil quality through the accumulation of organic matter, which in the long term increases the capitalisation of the enterprise's land assets.

In concluding our review of technologies for growing energy poplar and root chicory seed production in the Forest-Steppe region, we must recognise that these two seemingly distinct areas are part of a unified response by agricultural science to global climatic and economic challenges.

The main conclusion drawn from the research and practical experience is that resource efficiency is achieved not only through savings in fertilisers or fuel, but through the biological suitability of the crop to its environment. In the conditions of the Western and Right-Bank Forest-Steppe, where water scarcity is becoming increasingly acute, poplar and chicory demonstrate high adaptability.

The use of elongated poplar cuttings and no-till cultivation for chicory is not merely a technical method, but a strategy for plant survival during critical growth phases. This allows for the stabilisation of biomass and seed yields even in years with extreme hydrothermal conditions.

The establishment of poplar plantations should be viewed not as an alternative to traditional forestry, but as a tool for the energy self-sufficiency of agricultural enterprises. The high energy yield of poplar makes it an ideal fuel for the internal needs of the farm. For example, the energy obtained from one hectare of poplar can power the entire cycle of processing and drying chicory seeds from an area of 20–30 hectares. This creates a closed, energy-independent ecosystem where the waste from one process becomes fuel for another.

Chicory seed production in the Forest-Steppe region opens up huge prospects for high-margin exports. Against the backdrop of growing global demand for inulin and healthy food, domestic seeds grown using adaptive technologies are capable of competing with the best European varieties. For agricultural management, this means a shift from a strategy of 'survival through gross grain yield' to a strategy of 'profit per hectare through high technology'.

In light of the introduction of carbon offset mechanisms, the poplar's ability to sequester significant volumes $_{of\ CO_2}$becomes a tangible financial asset. Enterprises that integrate energy plantations into their structure not only provide themselves with heat but also improve their 'green profile', which in the future will allow them to receive additional preferences in international markets.

The prospects for the sector's further development lie in precision agriculture. Further refinement of technological elements should be based on the use of:

− genetically modified (non-invasive) poplar clones with increased drought resistance.

− drones for the precise application of micro-fertilisers in chicory seedbeds.

− machine vision systems to predict the optimal timing for desiccation and seed harvesting.

The forest-steppe region of Ukraine has every chance of becoming a leader in the production of renewable energy and high-quality industrial crops. However, this requires specialists at modern agricultural enterprises to understand biological processes, to be bold in implementing innovations, and to view agronomy not merely as work in the field, but as the complex management of the planet's biospheric resources.

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AGROPHYSICAL PROPERTIES OF RECULTIVATED SOILS AND THEIR CHANGES UNDER THE INFLUENCE OF FOREST PLANTATIONS OF VARIOUS SPECIES COMPOSITION

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АГРОФІЗИЧНІ ВЛАСТИВОСТІ РЕКУЛЬТИВОВАНИХ ҐРУНТІВ ТА ЇХ ЗМІНА ПІД ВПЛИВОМ ЛІСОВИХ НАСАДЖЕНЬ РІЗНОГО ПОРОДНОГО СКЛАДУ

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Abstract

The agrophysical properties of soils reclaimed after ilmenite ore extraction at Shershnivske forestry (Zhytomyr Polissia) and the patterns of their changes under forest stands of various species composition were investigated. On three temporary sample plots in 52-year-old Scots pine (*Pinus sylvestris* L.) stands with varying proportions of deciduous species, forest inventory and agrochemical soil analysis were conducted. It was established that the introduction of deciduous species (silver birch, black locust) into stand composition increases humus content by 10–14% (from 1.32 to 1.50%) and reduces soil salt acidity by 2–7% compared to pure pine stands. Productivity indicators (timber stock of 274–320 m³/ha versus 145 m³/ha in monocultures of age class 4–5) and sanitary condition (health index 2.6 in mixed stands versus 3.1–3.3 in pure pine stands) confirm the effectiveness of mixed reforestation schemes. Forest type transformation over 40 years (from A_1C to B_2DC) indicates gradual restoration of edaphic conditions under forest plantations.

Анотація

Досліджено агрофізичні властивості рекультивованих після видобутку ільменітових руд ґрунтів Шершнівського лісництва (Житомирське Полісся) та закономірності їх зміни під впливом лісових насаджень різного породного складу. На трьох тимчасових пробних площах у 52-річних деревостанах сосни звичайної (*Pinus sylvestris* L.) із різною часткою листяних порід проведено таксаційний облік та агрохімічний аналіз ґрунтів. Встановлено, що введення до складу насаджень листяних порід (берези повислої, робінії звичайної) підвищує вміст гумусу на 10–14% (від 1,32 до 1,50%) та зменшує сольову кислотність ґрунту на 2–7% порівняно із чистими сосняками. Показники продуктивності (запас деревини 274–320 м³/га проти 145 м³/га у монокультурах 4–5 класу віку) та санітарного стану (індекс стану 2,6 у мішаних насадженнях проти 3,1–3,3 у чистих сосняках) підтверджують ефективність змішаних схем лісовідновлення. Трансформація типів лісу за 40 років (від A_1C до $B_2ДС$) свідчить про поступове відновлення едафічних умов під лісовими насадженнями.

Keywords: *Pinus sylvestris*, *Heterobasidion annosum*, humification, soil acidity, Tyurin method, ilmenite quarry, forest typological analysis, stand species composition, Irshansk Mining and Processing Plant.

Ключові слова: *Pinus sylvestris, Heterobasidion annosum*, гуміфікація, кислотність ґрунту, метод Тюріна, ільменітовий кар'єр, лісотипологічний аналіз, породний склад деревостану, Іршанський ГЗК.

ВСТУП

Видобуток корисних копалин відкритим способом спричиняє глибоке порушення ґрунтового покриву, призводячи до формування техногенних ландшафтів із принципово іншими фізичними, хімічними та біологічними властивостями субстрату (Bradshaw, 1997). Регіон Житомирського Полісся, де впродовж 1970–1980-х рр. здійснювався масштабний видобуток ільменітових руд Іршанським гірничо-збагачувальним комбінатом (ІГЗК), є однією з найбільш постраждалих лісогосподарських зон України.

Рекультивовані після гірничодобувних робіт ґрунти в умовах Полісся переважно представлені легкими за механічним складом субстратами (піщаними і супіщаними) із низькою родючістю, порушеним водним режимом та відсутнім природним гумусовим горизонтом (Шомко, Давидова, 2024). Ці характеристики суттєво обмежують лісорослинний потенціал і визначають ризики деградації насаджень у середньостроковій перспективі.

Лісова рекультивація розглядається як найефективніший спосіб відновлення таких земель (Frouz, 2013). Численні дослідження підтверджують, що деревні насадження поступово покращують агрофізичні властивості ґрунту: підвищують вміст органічної речовини, знижують щільність, покращують водний режим і активізують мікробіологічну діяльність (Misebo et al., 2023; Świątek & Pietrzykowski, 2021; Turko et al., 2025). Однак ефективність цих процесів суттєво залежить від породного складу насадження.

Ключовою проблемою лісовідновлення на рекультивованих землях Полісся є переважання чистих монокультур сосни звичайної, що мають низьку екологічну стійкість і призводять до швидкого поширення кореневої губки (*Heterobasidion annosum* (Fr.) Bref.). Водночас залишається недостатньо вивченим порівняльний вплив чистих соснових і змішаних насаджень на агрофізичний стан рекультивованих ґрунтів у реальних виробничих умовах Шершнівського лісництва.

Мета роботи – дослідити агрофізичні властивості рекультивованих ґрунтів та встановити закономірності їх зміни під впливом лісових насаджень різного породного складу в умовах Шершнівського лісництва Коростенського надлісництва.

АНАЛІЗ ЛІТЕРАТУРНИХ ДЖЕРЕЛ

Проблема відновлення агрофізичних властивостей рекультивованих ґрунтів під лісовими насадженнями має значну наукову базу. Загальновизнано, що техногенні субстрати характеризуються підвищеною щільністю, піщано-супіщаним гранулометричним складом та обмеженою водоутримувальною здатністю (Misebo et al., 2023; Świątek & Pietrzykowski, 2021). Рекультивовані площі Житомирського Полісся після видобутку ільменіту мають піщаний та супіщаний гранулометричний склад із низькою вологоутримувальною здатністю і низьким вмістом поживних речовин (Шомко, Давидова, 2024).

Результати польових і лабораторних досліджень переконливо свідчать, що лісові насадження здатні суттєво покращувати фізичні й агрохімічні властивості техногенних субстратів, однак ефект є тривалим і залежить від видового складу деревостану. Встановлено три ключові напрями впливу деревних рослин: збільшення вмісту органічного вуглецю за рахунок надходження рослинних решток, зниження щільності ґрунту та підвищення його пористості, а також поступове зростання вологоутримувальної здатності.

Щодо конкретних деревних порід, важливо відзначити особливу роль змішаних насаджень. Сосна звичайна на рекультивованих ґрунтах за 20–35 років відновлює лише близько 20–27% запасів органічного вуглецю порівняно з природними лісами; зміни концентруються у підстилці та верхніх 0–5 см ґрунтового профілю (Kołodziej et al., 2016). Натомість змішані насадження сосни з березою суттєво покращують кореневу біомасу і ґрунтові умови порівняно з монокультурами (Шомко, Давидова, 2024; Rahmonov et al., 2020).

Особливої уваги заслуговує роль азотфіксуючих видів. Дослідження А. А. Сірика підтверджують, що навіть незначна домішка робінії звичайної (*Robinia pseudoacacia* L.) здатна суттєво підвищити вміст доступного азоту у бідних техногенних ґрунтах (Сірик, Фучило, 2017). Цей ефект пояснюється симбіотичною азотфіксацією у кореневій системі та швидкою мінералізацією листяного опаду.

Трав'янисті угруповання у соснових насадженнях Полісся підвищують вміст гумусу, водотривкість агрегатів, водопроникність і покращують реакцію ґрунтового середовища (Spasić et al., 2023). Рекомендується застосовувати комплексну біологічну рекультивацію з обов'язковим введенням листяних порід і підліску, оскільки чисті соснові культури формують менш сприятливі ґрунтові властивості (Pietrzykowski et al., 2015; Pietrzykowski & Krzaklewski, 2007).

Таким чином, існуючі дослідження переконливо обґрунтовують перевагу змішаних насаджень над монокультурами для відновлення агрофізичних властивостей рекультивованих ґрунтів (Pretzsch et al., 2017; Pietrzykowski & Krzaklewski, 2007). Однак конкретні кількісні дані щодо змін вмісту гумусу та кислотності ґрунтів під різними типами насаджень на рекультивованих землях Житомирського Полісся в науковій літературі представлені недостатньо.

МАТЕРІАЛИ ТА МЕТОДИ

Дослідження проводились на рекультивованих після видобутку ільменітових руд землях Шершнівського лісництва Коростенського надлісництва Філії «Столичний лісовий офіс» ДП «Ліси України» (Житомирська обл.). Об'єктами дослідження слугували 52-річні лісові культури, створені у 1973 р. на площах, що вийшли з користування Іршанського ГЗК.

Надлісництво розташоване в зоні Українського Полісся. Переважаючими типами ґрунтів є підзолисті з різним механічним складом – від піщаних до суглинистих. Середньорічна температура становить 7–8°С, кількість опадів – 600–700 мм. Клімат помірно-континентальний з атлантичним впливом.

Дослідження проведено на трьох тимчасових пробних площах (ТПП) розміром 0,2 га у 39-му таксаційному кварталі. ТПП закладено за вимогами до лісовпорядних пробних площ, мінімальна кількість дерев домінуючої породи – не менше 200 шт./га. Пробні площі відрізняються породним складом деревостанів:

ТПП 1 (виділ 8): 10Сз+Бп, чиста культура сосни з домішкою берези (890 шт./га);

ТПП 2 (виділ 9): 10Сз+Бп, чиста культура сосни з домішкою берези (1000 шт./га);

ТПП 3 (виділ 14): 9Сз+1Акб+Бп, сосна з домішкою робінії звичайної (*Robinia pseudoacacia* L.) та берези (1030 шт./га).

На пробних площах проводили суцільний перееблік дерев за породами, ступенями товщини, диференціацію за класами росту і розвитку (класи Крафта) та категоріями санітарного стану. Для характеристики санітарного стану використовувався індекс стану (Іс):

$$I_C = \frac{1}{N} \times \sum_{j=1}^{N} k_j \times n_j$$

де: I_C – показник стану; k_j – j-та категорія санітарного стану (від I до VI); n_j – кількість дерев у j-ій категорії санітарного стану; N – загальна кількість дерев на пробній площі.

Відбір зразків ґрунту проводився з горизонту 0–20 см. Вміст гумусу визначали за методом І. В. Тюріна (метод мокрого спалювання), реакцію ґрунтового розчину (pH сольової витяжки) – потенціометричним методом у сольовій витяжці (1 н KCl). Лісовпорядний аналіз охоплював 62 таксаційних виділи на площі 417,8 га станом на 2017 р.

Порівняльний аналіз динаміки деревостанів та ґрунтових умов проводився за матеріалами базових лісовпорядкувань 1977, 1987, 1997 і 2017 рр. Лісова типологія визначалась за методикою типологічного аналізу. Статистичне оцінювання різниці між пробними площами проводилось методом однофакторного дисперсійного аналізу.

РЕЗУЛЬТАТИ ДОСЛІДЖЕНЬ

На землях Шершнівського лісництва, що вийшли з користування після діяльності ІГЗК, починаючи з початку 1970-х рр. було створено лісові культури на площі понад 583 га (9,9% від загальної площі лісництва 5914,3 га). За матеріалами лісовпорядкування 2017 р. проаналізовано 62 таксаційних виділи на площі 417,8 га, що охоплює 72% від загальної площі рекультивованих культур.

Розподіл за типами лісорослинних умов показав переважання бідних борових (А) типів – 63,3% (264,5 га), субори (В) представлені на 33,8% (141,3 га), сугруди (С) – на 2,9% (12,0 га). Домінує свіжий гігротоп (79,8%), сухий – 18,8%. Основна лісоутворювальна порода – сосна звичайна (97,4% площ), вільха чорна представлена на 2,5%, береза повисла та акація біла – по 0,4–0,5%.

Критичним фактором є те, що 279,9 га (67,0% від площ рекультивованих сосняків) уражені осередками кореневої губки. Ці насадження переважно чисті за складом (10Сз), 4–5 класу віку, свіжих борових та суборових типів лісу з відносною повнотою вище 0,8.

Порівняльний аналіз матеріалів чотирьох лісовпорядкувань (1977–2017 рр.) у 39-му кварталі свідчить про суттєву позитивну трансформацію ґрунтових і рослинних умов під впливом лісових насаджень (табл. 1).

Таблиця 1

Динаміка лісівничо-таксаційних показників лісових культур у 39-му кварталі (1977–2017 рр.)

Рік	Площа, га	Склад	Тип лісу	Вік, роки	Висота, м	Бонітет	Повнота	Запас, м³/га
1977	57,8	7Сз2Бп1Влч	A_1С (сухий сосновий бір)	5	1	III	0,90	10
1987	33,0	7Сз2Бп1Влч	A_2С (свіжий сосновий бір)	15	6	I	0,90	60
1997	33,0	8Сз1Бп1Влч	B_2ДС (свіжий дубово-сосновий субір)	25	10	I	0,90	130
2017	13,0	10Сз+Бп+Влч	B_2ДС (свіжий дубово-сосновий субір)	45	17	I	0,80	260

Аналіз даних показав, що вже через 10 років після посадки (1987 р.) відбулась зміна типу лісу з сухого соснового бору (A_1С) на свіжий (A_2С), а клас бонітету підвищився з III до I. Впродовж наступного десятиліття (до 1997 р.) трофотоп зазнав трансформації від борового (А) до суборового (В): тип лісу змінився на свіжий дубово-сосновий субір (B_2ДС), що свідчить про суттєве покращення едафічних умов. Запас деревини за весь 40-річний період збільшився від 10 м³/га до 260–300 м³/га, а клас бонітету стабілізувався на рівні I–Ia. Зі зміною трофотопу у живому надґрунтовому покриві з'явились рослини-індикатори лісових ценозів: зіновать руська, ожика волосиста, верес звичайний, золотушник звичайний.

Результати агрохімічного аналізу ґрунтів на трьох пробних площах у 52-річних насадженнях відображено у таблиці 2.

Таблиця 2

Агрофізичні параметри ґрунту на тимчасових пробних площах (горизонт 0–20 см)

№ п/п	Склад деревостану	Кількість, шт/га	Бонітет	Повнота	Запас, м³/га	Горизонт, см	Гумус, %	pH сол.
1	10Сз+Бп	890	I	0,64	274	0–20	1,32	4,5
2	10Сз+Бп	1000	I	0,71	305	0–20	1,35	4,7
3	9Сз+1Акб+Бп	1030	Ia	0,75	320	0–20	1,50	4,8

Найвищий вміст гумусу (1,50%) зафіксовано на ТПП 3, де у складі деревостану присутня робінія звичайна та підлісок із горобини звичайної (*Sorbus aucuparia* L.) із зімкнутістю 25%. На ТПП 1 і ТПП 2 (чисті сосново-березові насадження) вміст гумусу становив відповідно 1,32 та 1,35%. За абсолютним значенням усі три ділянки належать до групи слабогумусованих ґрунтів (1–2%), проте різниця між ними становить 10–14%.

Реакція ґрунтового середовища (pH сол.) закономірно змінюється зі збільшенням участі листяних порід: від 4,5 на ТПП 1 та 4,7 на ТПП 2 до 4,8 на ТПП 3. Підкислення ґрунту під чистими сосняками є типовою реакцією через утворення хвойного опаду (голок), що повільно мінералізується та продукує органічні кислоти. Введення листяних порід, особливо азотфіксуючої робінії, сприяє нейтралізації ґрунтового середовища та пришвидшенню мінералізації органічних речовин.

Таксаційні показники підтверджують взаємозв'язок між породним складом і ґрунтовими умовами. На ТПП 3 (9Сз+1Акб+Бп) запас деревини склав 320 м³/га при середня зміна запасу 6,1 м³/га, що перевищує відповідні показники ТПП 1 та ТПП 2 на 3,3–14,5%. Відносна повнота на ТПП 3 (0,75) є вищою, ніж на ТПП 1 (0,64) і ТПП 2 (0,71). Ці відмінності підтверджують більш сприятливий ґрунтово-трофічний режим на ділянці зі змішаним складом.

Деревостани на всіх трьох ТПП уражені кореневою губкою (*Heterobasidion annosum* (Fr.) Bref.). Однак інтенсивність ураження суттєво відрізняється залежно від породного складу. Середній індекс санітарного стану на ТПП 1 становив 3,3, на ТПП 2 – 3,1, на ТПП 3 – 2,6, що є мінімальним значенням і свідчить про вищу стійкість мішаного деревостану.

На ТПП 3 частка дерев без ознак ослаблення (I категорія) та слабо ослаблених (II категорія) становить 28,8 і 27,5%, що суттєво вище, ніж на ТПП 1 (19,4% та 17,2%) та ТПП 2. Найменша частка сухостійних дерев (12,5%) також зафіксована на ТПП 3. Достовірність відмінностей між ТПП 3 і ТПП 1 підтверджена результатами однофакторного дисперсійного аналізу: Fф=7,59 > F0,95=3,89 (P=0,006).

Аналіз розподілу дерев за класами Крафта показав, що на ТПП 3 частка дерев, представлених у I–II–III класах (провідні, хорошого і нормального росту), становить 72,6%, тоді як на ТПП 1 і ТПП 2 – лише 53,6% і 51,7% відповідно. Ця закономірність свідчить про більш збалансовану вертикальну структуру деревостану в мішаних насадженнях.

Узагальнені показники впливу різного породного складу насаджень на агрофізичні параметри ґрунту та стан деревостану наведено у таблиці 3.

Таблиця 3

Порівняльна характеристика показників ґрунту і деревостану за породним складом насаджень*

Показник / Фактор	Чисті сосняки (10Сз)	Сосна+Береза (10Сз+Бп)	Сосна+Акація+Береза (9Сз+1Акб+Бп)
Вміст гумусу, %	1,18–1,25	1,32–1,35	1,50
pH сол.	4,2–4,4	4,5–4,7	4,8
Щільність ґрунту, г/см³	Підвищена	Знижена	Найнижча
Запас деревини, м³/га	до 145	274–305	320
Індекс санітарного стану	3,3–3,5	3,1–3,3	2,6
Частка пошкоджених дерев, %	до 75	60–65	≈50

Примітка: побудовано на основі власних досліджень (Турко та ін., 2025)

Отримані результати узгоджуються із загальними закономірностями, встановленими у вітчизняній та зарубіжній науковій літературі. Підвищення вмісту гумусу від 1,32–1,35% (чисті сосняки) до 1,50% (насадження з робінією) корелює з даними Malewski et al. (2023), які встановили, що додавання органічної речовини у вигляді деревних решток листяних порід суттєво підвищує вміст C, N, P та різноманіття ґрунтового мікробіому, наближаючи його до типово лісового.

Зміна pH сол. від 4,5 до 4,8 на ділянках з листяними породами є статистично значущою і свідчить про пом'якшення кислотності ґрунтів. Важливо, що навіть незначна частка листяних порід у складі деревостану (10% робінії на ТПП 3) справляла відчутний меліоративний ефект. Це підтверджує дані А. А. Сірика щодо азотфіксуючої ролі робінії (Сірик, Фучило, 2017) та дослідження М. М. Калініна щодо позитивного впливу берези на ґрунтові умови в мішаних насадженнях (Калінін, 2001).

Трансформація типів лісу від A_1C до $B_2ДС$ впродовж 40-річного спостереження є надзвичайно показовою. Вона відображає реальне покращення трофності ґрунтового середовища – явище, описане рядом закордонних дослідників (Pietrzykowski et al., 2015; Kołodziej et al., 2016). При цьому зміна бонітету з III до I–Ia класу підтверджує, що рекультивовані ґрунти при правильному підборі породного складу здатні забезпечити продуктивність на рівні природних лісових угідь (Vacek et al., 2021).

Нижчий індекс санітарного стану на ТПП 3 (2,6 проти 3,1–3,3) пояснюється кількома механізмами: по-перше, листяні породи розривають кореневі взаємозв'язки між сосновими деревами, ускладнюючи поширення *Heterobasidion annosum*; по-друге, листяний опад активізує мікробіологічні процеси і сприяє формуванню антагоністичних до патогену ґрунтових мікроорганізмів; по-третє, підліск із горобини звичайної забезпечує сприятливий мікроклімат, що також підвищує стійкість дерев.

Слід зазначити, що незважаючи на очевидні переваги змішаних насаджень, усі досліджувані ділянки належать до групи слабогумусованих ґрунтів (вміст гумусу 1–2%). Це підтверджує висновок

огляду літератури: 50 років лісового господарювання недостатньо для повного відновлення агрофізичних властивостей до рівня природних лісових ґрунтів. Для прискорення процесу доцільно застосовувати комплексну біологічну рекультивацію із внесенням органічних матеріалів (деревних решток, компосту кори), що активізує мікробіологічні процеси і наближає властивості ґрунту до лісового типу (Malewski et al., 2023).

ВИСНОВКИ

1. Рекультивовані після видобутку ільменітових руд ґрунти Шершнівського лісництва характеризуються низьким вмістом гумусу (1,32–1,50%) та кислою реакцією середовища (pH сол. 4,5–4,8). Усі ділянки належать до групи слабогумусованих ґрунтів, що свідчить про повільне відновлення органічного профілю після техногенного порушення навіть за 50 років лісової рекультивації.

2. Породний склад насадження суттєво впливає на агрофізичні властивості ґрунту. Введення листяних порід – берези повислої (*Betula pendula* Roth.) та робінії звичайної (*Robinia pseudoacacia* L.) – підвищує вміст гумусу на 10–14% та зменшує кислотність ґрунту на 2–7% порівняно з чистими сосновими монокультурами.

3. Мішані деревостани (9Сз1Акб+Бп) забезпечують вищу продуктивність: запас деревини 320 м³/га та середня зміна запасу 6,1 м³/га, що перевищує показники чистих сосняків на 3,3–14,5%.

4. Лісові насадження спричиняють поступову трансформацію ґрунтово-рослинних умов. Впродовж 40 років (1977–2017 рр.) відбулася зміна типу лісу від сухого соснового бору (A_1С) до свіжого дубово-соснового субору (B_2ДС), що свідчить про покращення трофності рекультивованих субстратів під впливом деревостанів.

5. Мішані насадження за участю листяних порід виявляють вищу стійкість до кореневої губки: індекс санітарного стану на ділянці 9Сз1Акб+Бп становив 2,6, тоді як на чистих сосново-березових ділянках – 3,1–3,3 (різниця достовірна при P=0,006).

6. Для лісовідновлення на рекультивованих землях Житомирського Полісся рекомендується уникати створення чистих монокультур сосни звичайної, надаючи перевагу змішаним схемам садіння із введенням берези повислої та робінії звичайної (10–15% від кількості посадкових місць). Це забезпечить покращення едафічних умов та підвищення біологічної стійкості насаджень.

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BIOLOGICAL SCIENCES

PHARMACOGENETICS OF ANTIPLATELET THERAPY: A PERSONALIZED APPROACH TO THE SELECTION OF P2Y12 RECEPTOR INHIBITORS (REVIEW)

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Abstract

Introduction

The wide variability in response to clopidogrel, due to genetic factors, remains a significant problem in cardiology and is associated with an increased risk of thrombotic complications.

Objective

To summarize current data on the pharmacogenetics of P2Y12 receptor inhibitors and assess the clinical significance of a personalized approach to their prescription.

Materials and Methods

An analysis of key publications from the PubMed database as well as current clinical guidelines from the ESC and CPIC, was conducted.

Results:

Carriage of loss-of-function alleles of the CYP2C19 gene (*2, *3) is a key prognostic factor for reduced efficacy of clopidogrel and increased risk of thrombotic events. In patients with intermediate (IM) and poor metabolizer (PM) phenotypes, therapy with ticagrelor or prasugrel demonstrates superiority over clopidogrel. Clinically validated algorithms for selecting antiplatelet agents based on genotyping have been developed.

Keywords: pharmacogenetics, antiplatelet agents, clopidogrel, CYP2C19, personalized medicine, acute coronary syndrome.

INTRODUCTION

Cardiovascular diseases, particularly acute coronary syndrome (ACS), remain the leading cause of mortality among the adult population. The modern treatment strategy for patients with ACS and after percutaneous coronary interventions (PCI) is based on dual antiplatelet therapy, including acetylsalicylic acid and a P2Y12 receptor inhibitor. According to the latest 2023 guidelines of the European Society of Cardiology (ESC), this approach significantly reduces the risk of recurrent thrombotic events [8].

Despite proven efficacy, the response to the most commonly prescribed P2Y12 receptor inhibitor—clopidogrel—is characterized by significant interindividual variability. In some patients, the phenomenon of "high on-treatment platelet reactivity" (HPR) is observed, which is associated with a 3–5-fold increase in the risk of major cardiovascular events. Genetic factors play a key role in this. As demonstrated by Mega JL in a landmark 2009 study, polymorphism of the CYP2C19 gene is the main determinant of clopidogrel effectiveness [1].

The aim of this review is to provide a systematic analysis of current data on the pharmacogenetics of P2Y12 receptor inhibitors and to evaluate the clinical prospects of a personalized approach to their prescription.

MOLECULAR BASIS OF THE PHARMACOGENETICS OF P2Y12 RECEPTOR INHIBITORS AND THEIR SIGNIFICANCE FOR RATIONAL SELECTION OF AN ANTIPLATELET AGENT IN CLINICAL PRACTICE

General characteristics of P2Y12 receptors and their role in platelet aggregation

P2Y12 receptors are key components of the platelet activation system. They are Gi protein–coupled receptors located on the platelet membrane and are activated by adenosine diphosphate (ADP). Upon ADP binding, adenylate cyclase is inhibited, cyclic AMP levels decrease, and glycoprotein IIb/IIIa receptors are subsequently activated, leading to platelet aggregation. Blockade of P2Y12 receptors is one of the main therapeutic strategies in the prevention of arterial thrombosis.

Comparative Characteristics of Drugs

Clopidogrel: Molecular Structure and Metabolic Pathway

Clopidogrel belongs to the thienopyridine class and is an inactive prodrug requiring a complex two-step activation in the liver. After oral administration, approximately 85% of the drug is hydrolyzed by esterases into an inactive metabolite, while only 15% undergoes

biotransformation to form the active thiol metabolite [9].

The first activation step is primarily mediated by the CYP2C19, CYP1A2, and CYP2B6 isoenzymes, producing the intermediate metabolite 2-oxo-clopidogrel. The second step, involving hydrolysis of the thiolactone ring, is mainly catalyzed by CYP2C19, CYP3A4, CYP2B6, and CYP2C9. The resulting active metabolite contains a free thiol group, which forms an irreversible disulfide bond with the cysteine residue of the P2Y12 receptor.

The critical role of CYP2C19 in both steps makes this isoenzyme the rate-limiting factor of the entire process. Kazui et al. (2010) quantitatively assessed the contribution of various isoenzymes, confirming that CYP2C19 activity determines the speed and completeness of active metabolite formation [9].

Ticagrelor: Direct Reversible Antagonist

Ticagrelor is a cyclopentyl-triazolopyrimidine and differs fundamentally from thienopyridines in both mechanism of action and metabolism. It is a direct reversible P2Y12 receptor antagonist that does not require metabolic activation to bind the receptor. Ticagrelor itself and its major active metabolite AR-C124910XX (formed via CYP3A4) have similar pharmacological activity.

Ticagrelor metabolism occurs mainly via CYP3A4, producing both active and several inactive metabolites. Importantly, although ticagrelor is metabolized by cytochrome P450 enzymes, its pharmacodynamic effect is minimally dependent on CYP2C19 activity. A genetic substudy of PLATO, conducted by Wallentin et al., demonstrated that the efficacy and safety of ticagrelor did not differ among carriers of different CYP2C19 alleles [3].

Prasugrel: Efficient Thienopyridine Prodrug

Prasugrel, like clopidogrel, belongs to the thienopyridine class but has a simpler and more efficient metabolic pathway. After absorption, the drug is rapidly hydrolyzed by esterases (mainly carboxylesterase 1 — CES1) to form an intermediate thiolactone, which is then converted in a single step to the active metabolite via CYP3A4 and CYP2B6.

The key difference between prasugrel and clopidogrel is the minimal role of CYP2C19 in its activation. This was convincingly demonstrated in the TRITON-TIMI 38 genetic substudy, where Mega et al. showed that CYP2C19 polymorphism did not affect clinical outcomes in patients receiving prasugrel [4].

Table 1.

Comparative Characteristics of P2Y12 Receptor Inhibitors

Parameter	Clopidogrel	Ticagrelor	Prasugrel
Chemical class	Thienopyridine	Cyclopentyl-triazolopyrimidine	Thienopyridine
Type of antagonism	Irreversible	Reversible	Irreversible
Need for activation	Yes (prodrug)	Partial (active itself)	Yes (prodrug)
Key metabolic enzymes	CYP2C19, CYP3A4, CYP2B6	CYP3A4	CES1, CYP3A4, CYP2B6
Role of CYP2C19	Critical (rate-limiting) [1]	Minimal [3]	Minimal [4]
Onset of action	2–6 h	2–4 h	30 min – 4 h
Duration of action	5–7 days	3–4 days	5–7 days
Main adverse effects	Bleeding, GI disturbances	Bleeding, dyspnea	Bleeding
Response variability	High	Low	Low

Key Genetic Polymorphisms and Their Clinical Significance

CYP2C19 Gene: Structure, Allelic Polymorphism, and Phenotypes

The CYP2C19 gene is located on chromosome 10q24 and consists of 9 exons. To date, more than 35 allelic variants have been identified, which determine enzyme activity and, consequently, the metabolic phenotype. According to the classification presented in the CPIC guidelines, four main phenotypes are distinguished [7, 10]:

Ultrarapid Metabolizers (UM)

Genotype: *17/*17, *1/*17

Frequency in European populations: 20–25%

Enzyme activity: Increased (enhanced gene transcription)

Clinical significance: Accelerated formation of the active clopidogrel metabolite, potentially higher bleeding risk. However, the clinical relevance of this risk remains debated [10].

Normal Metabolizers (NM)

Genotype: *1/*1

Frequency in European populations: 35–50%

Enzyme activity: Normal

Clinical significance: Standard doses of clopidogrel provide adequate antiplatelet effect. This group serves as the reference for comparisons.

Intermediate Metabolizers (IM)

Genotype: *1/*2, *1/*3, *2/*17

Frequency in European populations: 25–35%

Enzyme activity: Reduced (approximately 50% of normal)

Clinical significance: Moderate reduction in active metabolite formation, increased risk of thrombotic events, especially in high-risk situations [1, 2].

Poor Metabolizers (PM)

Genotype: *2/*2, *2/*3, *3/*3

Frequency in European populations: 2–5% (up to 15–20% in Asian populations)

Enzyme activity: Severely reduced or absent

Clinical significance: Minimal formation of the active metabolite, extremely high risk of thrombotic complications, particularly stent thrombosis [1, 2].

Molecular Mechanisms of Loss-of-Function Alleles

The CYP2C19*2 allele (c.681G>A, rs4244285) is the most common loss-of-function variant. This single nucleotide substitution in exon 5 creates an aberrant splice site, resulting in a frameshift and premature stop codon. The resulting truncated protein is enzymatically inactive.

The CYP2C19*3 allele (c.636G>A, rs4986893) is more common in Asian populations. The substitution in exon 4 also creates a premature stop codon, leading to synthesis of an inactive enzyme.

Evidence Base: Key Studies and Meta-Analyses

Mega JL (2009) was the first to fully demonstrate the clinical significance of CYP2C19 polymorphism. In a cohort of over 2,000 ACS patients, carriers of loss-of-function alleles had a 53% increased risk of cardiovascular events [1].

A meta-analysis by Holmes (2011) summarized data from 9 studies including over 9,000 patients. The relative risk of stent thrombosis in carriers of loss-of-function alleles was 1.57 for heterozygotes and 2.42 for homozygotes compared to normal allele carriers [2].

Role of Other Candidate Genes

The ABCB1 (MDR1) gene encodes P-glycoprotein, an efflux transporter affecting clopidogrel absorption in the intestine. The C3435T polymorphism is associated with altered protein function, but its clinical significance remains controversial.

The PON1 (paraoxonase-1) gene was proposed in 2011 as a key enzyme in clopidogrel activation; however, subsequent studies did not confirm a significant role.

Clinical Studies of Personalized Therapy

TAILOR-PCI Study (2020)

TAILOR-PCI is the largest randomized controlled trial assessing the efficacy of a gene-guided antiplatelet therapy strategy. Pereira et al. included 5,302 ACS patients scheduled for PCI. Patients were randomized into two groups: standard clopidogrel therapy and genotype-guided therapy with ticagrelor for carriers of loss-of-function alleles.

Results: After 12 months, the gene-guided therapy group showed a 34% reduction in the primary composite endpoint (cardiovascular death, myocardial infarction, stroke, or severe recurrent ischemia) among carriers of loss-of-function alleles [5].

POPular Genetics Study (2019)

Claassens conducted a randomized study including 2,488 ACS patients undergoing primary PCI. Patients were assigned to genotype-guided therapy (ticagrelor or prasugrel for carriers of *2/*3 alleles) or standard therapy with ticagrelor/prasugrel for all.

Results: The rate of thrombotic events was similar between groups; however, the genotype-guided group had significantly fewer bleeding events, confirming the safety of a personalized approach [6].

PLATO Genetic Substudy (Ticagrelor vs. Clopidogrel)

Wallentin et al. analyzed the impact of CYP2C19 polymorphism in 18,624 ACS patients. Ticagrelor was superior to clopidogrel regardless of CYP2C19 genotype, with the greatest benefit observed in carriers of loss-of-function alleles [3].

TRITON-TIMI 38 Genetic Substudy (Prasugrel vs. Clopidogrel)

Mega et al. showed that among patients receiving prasugrel, efficacy and safety were not affected by CYP2C19 genotype, whereas clopidogrel-treated carriers of loss-of-function alleles had worse outcomes [4].

Practical Algorithms for Personalized Therapy Selection

Modern Approaches to Therapy Prescription based on accumulated evidence, two main strategies are identified:

Universal Strategy (Upfront Strategy): Administration of ticagrelor or prasugrel to all ACS patients without prior genotyping. This strategy is effective but may lead to overuse of more potent and expensive drugs.

Personalized Strategy (Genotype-Guided Strategy): Rapid genotyping followed by therapy selection based on the results. This approach optimizes the cost-effectiveness balance.

Detailed Algorithm for Therapy Selection Based on CYP2C19 Genotype

According to CPIC (2022) and ESC (2023) recommendations [7, 8]:

Phenotype: Ultrarapid Metabolizer (UM)

Genotype: *17/*17, *1/*17

Recommendation: Clopidogrel at standard dose (75 mg/day) is acceptable

Rationale: Increased CYP2C19 activity ensures adequate formation of the active metabolite. Monitoring is required due to potential bleeding risk

Phenotype: Normal Metabolizer (NM)

Genotype: *1/*1

Recommendation: Clopidogrel (75 mg/day) is indicated and considered standard therapy

Rationale: Normal enzyme activity ensures predictable antiplatelet response

Phenotype: Intermediate Metabolizer (IM)

Genotype: *1/*2, *1/*3

Recommendation: Ticagrelor (90 mg twice daily) or prasugrel (10 mg/day) is preferred, especially in high-risk patients

Rationale: Reduced CYP2C19 activity leads to clinically significant increased thrombotic risk

Phenotype: Poor Metabolizer (PM)

Genotype: *2/*2, *2/*3, *3/*3

Recommendation: Clopidogrel is contraindicated. Ticagrelor or prasugrel is the therapy of choice

Rationale: Minimal formation of the active metabolite renders clopidogrel ineffective

Special Clinical Situations

High ischemic risk patients:

Diabetes mellitus

Multivessel coronary artery disease

Left main coronary artery stenting

History of recurrent thrombosis

Even IM patients in this category should preferably receive ticagrelor or prasugrel.

High bleeding risk patients:

Elderly age

Chronic kidney disease

Coagulopathy

Concomitant use of anticoagulants

These patients require close monitoring and possible dose adjustment.

Clinical Recommendations and Practical Implementation

CPIC Recommendations (2022). The CPIC consortium developed detailed guidance for interpreting genotyping results and selecting therapy. Key points [7]:

PM patients should avoid clopidogrel.IM patients should consider alternative antiplatelets. If alternatives are unavailable for IM patients, clopidogrel dose may be doubled (150 mg/day)

ESC Recommendations (2023). The European Society of Cardiology notes [8]:

CYP2C19 genotyping may be considered to guide P2Y12 inhibitor selection in ACS patients (Class IIb, Level of Evidence B).In post-PCI patients, identification of PM or IM phenotype warrants switching from clopidogrel to ticagrelor or prasugrel.

Barriers to Implementation and Solutions

Organizational barriers: Lack of rapid tests (results take 3–7 days)

Need to coordinate logistics between hospital and laboratory

Solution: Implement point-of-care testing with results within 1–2 hours

Economic barriers: Cost of testing.Need for pharmacoeconomic justification

Solution: Cost-effectiveness analysis considering prevented complications.

Educational barriers: Limited physician awareness.Complexity of interpreting results. Solution: Educational programs and integration into training standards

Future Directions

Technological prospects: Development of multiplex panels for simultaneous analysis of multiple genes. Integration of pharmacogenetic data into electronic medical records.Decision support systems with automatic genotype interpretation

Scientific prospects: Study of polygenic risk scores/ Research on the role of pharmacogenetics in determining DAPT duration. Investigation of epigenetic factors

Conclusion

1. Pharmacogenetics of P2Y12 inhibitors is a prime example of translating fundamental knowledge of drug metabolism into a clinically useful tool for personalized medicine.

2. Identification of CYP2C19 polymorphism is a scientifically justified method for identifying patients at increased risk of clopidogrel inefficacy. Carriage of *2 and *3 alleles is associated with a significant increase in serious thrombotic events, especially stent thrombosis.

3. Ticagrelor and prasugrel, due to their metabolic profiles, are reliable alternatives for patients with unfavorable genotypes and demonstrate predictable antiplatelet effects independent of CYP2C19 polymorphism.

4. A personalized, genotype-guided antiplatelet strategy optimizes the balance of efficacy and safety, reserving more potent drugs only for patients who truly need them.

5. Despite organizational and economic barriers, pharmacogenetic testing has significant potential to become a new standard of care for patients requiring antiplatelet therapy.

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CURRENT STATUS OF FLIES THAT ARE POTENTIAL VECTORS OF LEISHMANIOSIS IN BARDA REGION

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BƏRDƏ RAYONUNDA LEYŞMANİOZUN POTENSİAL VEKTORLARI OLAN MIĞMIĞALARIN HAZIRKİ VƏZİYYƏTİ

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Abstract

The article shows that leishmaniasis has been registered in Azerbaijan since the beginning of the twentieth century, and as a result of implementation of certain measures anthroponotic cutaneous leishmaniasis has been practically eliminated, foci of visceral leishmaniasis have been cured, and the number of bruises has sharply decreased. Recently, changes in the population and causes of recovery of leishmaniasis carriers have been shown. Barda district is also considered one of the main disease foci in Azerbaijan. During scientific research conducted in 2025, the species found here were also captured and identified.

Keywords: leishmania, disease center, Phlebotomus, , identification, vector
Açar sözlər: Leyşmanioz, Phlebotomus, xəstəlik ocağı, preparat, identifikasiya,vektor

Müasir dövrdə leyşmanioz dünyanın 100 - ə yaxın ölkəsində qeydə alınmışdır. Ümumdünya Səhiyyə Təşkilatının sənədlərində leyşmanioz vacib və təhlükəli sayılan 6 tropik xəstəliklərdən biri kimi səciyyələndirilir. (D .Ejov., M, Daghe 2015)

Azərbaycanın təbii iqlim şəraiti leyşmanioz xəstəliyinin yayılması üçün münbitdir. Azərbaycanda leyşmaniozların 2 növü: Visseral (VL) və dəri leyşmaniozu (ADL) yayılmışdır. ADL – n epidemioloji zənciri belədir: xəstə insan---keçirici--- sağlam insan. Aralıq dənizi VL – un isə epidemioloji zənciri xəstəliyin mənbəyi kimi itləri də əhatə edir.(А.Ю.Наджафов 1969 s.163)

Leyşmaniozun obliqat transmissiv parazitar xəstəlikdir və xəstəliyinin keçiriciləri mığmığalardır. Dünyada mığmığaların təxminən 800 - ə yaxın növü aşkar edilmişdir və onların 90 – dan artıq növü leyşmaniozların keçiriciləri sayılır. Azərbaycanda isə bugünə kimi mığmığaların 15 növü aşkar edilmişdir.. Bunlar Phlebotomus və Sergentomyia cinslərinə aid növlərdir. Bu növlər arasından yalnız bir qismi Phlebotomus cinsinə aid olan növlər leyşmaniozun effektiv vektoru kimi fəaliyyət göstərir və onların paylanmasına, xəstəliyin yayılmasına birbaşa təsir göstərir. Sergentomyia cinsinə aid mığmığalar Azərbaycanda leyşmaniozların keçiriciləri kimi epidemioloji əhəmiyyət kəsb etmir. (H.F.Quliyeva 2014 səh.197)

Azərbaycanda XX əsrin 60 – cı illərində leyşmaniozlara qarşı mübarizə tədbirləri aparılmış nəticədə antroponoz dəri leyşmaniozu praktik ləğv olunmuş, visseral leyşmaniozun fəal ocaqları sağlamlaşdırılmış və xəstələnmələrin səviyyəsi kəskin sürətdə aşağı düşmüşdür.(А.Ю.Наджафов , И.Г.Мамедов 1969 с 61) Lakin son illərdə bu xəstəlik yenidən baş qaldırmış və Azərbaycanın 46 rayonunda yenidən qeyd olunmağa başlanıldı. Bu rayonlardan biri də əvvəldən Antroponoz dəri leyşmaniozunun

ocaqlarından sayılan Bərdə rayonudur. 1941 – cı ildə Bərdə rayonu haqqında П.П.Попов məlumat vermişdir. O,qeyd etmişdir ki, əsas dominant növ Ph.sergentidir. 2018 – ci ildə E.Ə.Hacıbəyova apardığı tədqiqatlarda Ph.sergenti növü əsas dominant növ olduğunu göstərmişdir.

2025 – ci ildə xəstəlik qeyd olunan yaşayış məntəqələrində ÜST –ün qəbul etdiyi metodikaya uyğun olaraq (gənəgərçək yağı sürtülmüş yarımperqament kağızlardan istifadə olunaraq) vektorlar tutuldu və laboratoriyada identifikasiya olundu. Əldə olunmuş materialın təhlili nəticəsində 7 növ aşkar edildi. Ph.sergenti(39), Ph. jacusieli (18), Ph.kandellaki (18), Ph.transcaucasicus (10), Ph.caucasicus (2), Ph.papatasi (5), Ph.tobi (1). Bunların arasında sayına görə çoxluq təşkil edən Ph.sergenti (39) növüdür. Bu növ ümumi keçiricilərin 41.935% - ni təşkil edir və Azərbaycanda dəri leyşmaniozunun keçiricisi hesab olunur.

Yaşayış məsafələri	Mığmığa növləri							
	Ph.papatasi	Ph.transcaucasicus	Ph.caucasicus	Ph.kandelaki	Ph.tobi	Ph.jacusieli	Ph.sergenti	Cəm
Zümürxan	5	1	-	6	1	4	6	23
Alaçadırlı	-	-	-	2	-	6	1	9
Kələntərli	-	4	-	8	-	2	7	21
Darğalar	-	5	2	2	-	4	-	13
100-lər məktəbi.	-	-	-	-	-	2	7	9
26- lar (Bərdə)	-	-	-	-	-	-	18	18
Cəm	5	10	2	18	1	18	39	93
faiz	5.376%	10.752%	2.15%	19.354%	1.075%	19.354%	41.935%	100%

Tədqiqat zamanı topladığımız qum milçəkləri arasında diqqətəlayiq bir nümunə aşkar etdik. Nümunə Ph.sergenti növünə aid olan dişi mığmığadır və o cücə tövləsindən toplanmış nümunələr arasında aşkar edilmişdir. Nümunənin vacibliyi mədəsində qan olmağıdır. Sonra həmin nümunə laboratoriyada yaxma hazırlanaraq mikroskop altında analiz edilmişdir.. Mədəsində qan olan həmin mığmığadan leyşmaniyanın promostiqot forması müəyyən olunmuşdur.

Mədəsində qan olan nümunə Ph.sergenti növünə aid mığmığadır. Bu tapıntı həmin növün potensial leyşmanioz vektoru olduğunu birbaşa təsdiqləyir və bölgədə xəstəliyin yayılma riskininin qiymətləndiriməsində əhəmiyyətli göstəricidir.

Beləliklə bu tapıntı infeksiya ilə mübarizənin gücləndirilməsi üçün onun hərtərəfli öyrənilməsini yeni tədqiqat metodlarının tətbiqini yeni metodlara əsaslanaraq mübarizə tədbirlərinin hazırlayıb tətbiq etməyi vacib edir.

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FRESHWATER ANGELFISH (*PTEROPHYLLUM SCALARE*) AS A MODEL ORGANISM: BIOLOGY AND ITS USE IN SCIENTIFIC RESEARCH

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Abstract

The use of model organisms is essential for studying physiological, biochemical, and ecological processes in living systems. Among aquatic models, the freshwater angelfish (*Pterophyllum scalare*) has gained attention due to its adaptability to laboratory conditions, sensitive behavioral and physiological responses, and relatively easy reproduction. This species is widely applied in studies of water quality, toxicology, radiation biology, and the effects of nanoparticles. Research on angelfish has addressed feeding biology, embryonic and larval development, environmental stress responses, social behavior, and susceptibility to diseases. The results highlight the value of *Pterophyllum scalare* as a reliable and informative model organism for both fundamental and applied biological research, contributing to a better understanding of aquatic ecosystems and the development of biotechnological approaches.

Keywords: Freshwater angelfish, *Pterophyllum scalare*, Model organism, Aquatic toxicology, Ecotoxicology, Behavior, Nanoparticles, Reproduction.

The use of model organisms in biological research plays a crucial role in the investigation of physiological, biochemical, and ecological processes occurring in living systems. In our previous studies, various biological objects have been used for experimental investigations. These studies were mainly conducted on plants, microorganisms, and certain animal organisms [1,2].

As plant models, agriculturally important species such as pea (*Pisum sativum*), wheat (*Triticum aestivum*), and maize (*Zea mays*) were investigated under laboratory conditions with regard to their physiological and developmental characteristics. In addition, naturally growing plants such as fig (*Ficus carica*), Eldar pine (*Pinus eldarica*), olive (*Olea europaea*), pomegranate (*Punica granatum*), and others were studied using the Electron Paramagnetic Resonance (EPR) spectroscopy method [3,4]. Among microorganisms, lactic acid bacteria (*Lactobacillus* spp.), yeast (*Saccharomyces cerevisiae*), and thermophilic bacteria were examined in terms of their resistance to various environmental factors and their metabolic activity [5,6]. Among animal organisms, scientific studies were carried out on terrestrial snails, laboratory rats, and fish, focusing on their responses to environmental changes, reactions to different stress factors, and physiological adaptation mechanisms [7,8,9,10].environmental changes, reactions to different stress factors, and physiological adaptation mechanisms [7,8,9,10].

As a continuation of these investigations, interest in aquatic model organisms has increased in order to study more complex biological responses, particularly those occurring in aquatic ecosystems [6]. In this context, the freshwater angelfish (*Pterophyllum scalare*) was selected as a suitable model organism for laboratory and experimental studies.

The freshwater angelfish (*Pterophyllum scalare*) is one of the freshwater fish species native to South America (Figure 1). It is naturally distributed mainly in the Amazon River basin and its tributaries. Angelfish are considered one of the most popular ornamental fish species maintained in aquarium conditions. Their body is laterally compressed and disc-shaped, while their long and slender fins give them an elegant appearance [7]. In natural habitats, their coloration is typically silvery with dark vertical bands; however, selective breeding has produced numerous color morphs, including black, marble, golden, and other variations. Angelfish are adapted to tropical climates, and the optimal water temperature for their survival is generally within the range of 24–28°C [8]. They prefer slightly acidic to neutral water, and they show better growth and development when the aquarium water pH is approximately between 6.0 and 7.5.

*Figure 1. Freshwater angelfish (*Pterophyllum scalare*).*

From a nutritional point of view, angelfish are considered omnivorous. They can feed on both plant-based and animal-based food sources. In their natural environment, they mainly consume plankton, insect larvae, small aquatic invertebrates, and various microscopic organisms. In terms of reproduction, angelfish exhibit interesting behavioral patterns. This species is capable of forming monogamous pairs and typically deposits eggs on plant leaves or smooth surfaces. The parental fish guard the eggs and provide care for developing embryos. Under aquarium conditions, when proper feeding, suitable water parameters, and sufficient swimming space are provided, angelfish can generally live for 8–10 years [9]. Their generally calm, but occasionally territorial, behavior should be taken into account when selecting compatible tank mates. The freshwater angelfish is frequently used as a model organism in aquarium biology and experimental zoology. Due to its good adaptation to laboratory conditions, relatively easy reproduction, and sensitive responses to changes in the aquatic environment, this species is applied in a variety of scientific studies [10].

Freshwater angelfish are particularly used in studies related to the assessment of water quality. Because their physiological and behavioral responses are sensitive to changes in the chemical composition of water, they are considered a suitable biological model for studying the effects of various pollutants, including heavy metals and other toxic compounds. Such studies make it possible to determine how anthropogenic impacts on aquatic ecosystems affect living organisms [6,7]. In addition, angelfish have also been used in the field of radiation biology. The effects of different doses of ionizing radiation on fish physiology, growth rate, and reproductive capacity have been investigated in this species. Such studies contribute to a better understanding of the mechanisms by which radiation affects aquatic organisms. In recent years, with the development of nanotechnology, the study of the effects of metal nanoparticles on aquatic organisms has also become increasingly relevant [8,9]. In these experiments, angelfish are used as test organisms. The effects of nanoparticles on fish metabolism, tissues, and overall vital activity can be effectively evaluated using this model.

Another advantage of using freshwater angelfish in laboratory research is that their behavioral characteristics can be easily observed. Stress factors, feeding conditions, and environmental changes may lead to alterations in behavioral responses, which represent important indicators in the evaluation of experimental outcomes. Thus, *Pterophyllum scalare* is widely used as a convenient model organism for conducting experimental studies in aquatic toxicology, ecotoxicology, radiation biology, and nanobiotechnology [10]. Numerous scientific studies have been carried out on *Pterophyllum scalare* in different fields. These studies mainly cover biology, aquaculture, toxicology, behavioral biology, and disease research.

Several scientific studies have investigated the effects of nutrition on the reproductive performance of angelfish. In fish fed with diets containing different protein levels, parameters such as egg number, fertilization rate, and larval hatching success were compared. Research has shown that angelfish fed live food exhibit shorter spawning intervals and higher hatching rates [6]. The embryonic and larval development of angelfish has also been extensively studied. Investigations have described the developmental stages following fertilization, including the blastula, gastrula, and segmentation stages. Embryonic development generally results in larval hatching approximately 72 hours after fertilization, and the parental fish actively care for the embryos.

In some studies, the effects of water chemical characteristics on the growth rate and survival of angelfish have been investigated [7]. For example, in experiments with different levels of water hardness, the growth and survival rates of juvenile fish were compared. The results demonstrated that certain levels of water hardness are more favorable for the development of angelfish. In recent years, angelfish have also been used in nanotechnology-related studies. For instance, the antibacterial effects of silver nanoparticles have been investigated, and these particles were found to inhibit the growth of *Vibrio fluvialis*. In experiments, fish treated with nanoparticles showed higher survival rates. Social behavior and stress responses in angelfish have also been studied [8]. Research has shown that when fish are isolated from the group, changes in locomotor activity can be observed. A reduction in activity levels has been reported in fish maintained individually for

prolonged periods. Other studies on angelfish have investigated bacterial, fungal, and parasitic diseases. It has been shown that various microorganisms (for example, *Aeromonas*, *Pseudomonas*, and others) can cause infections in fish, leading to high mortality rates.

The freshwater angelfish is one of the important model organisms in laboratory and aquarium biology. Research conducted on this species mainly covers feeding biology, embryonic development, the effects of the aquatic environment, diseases, behavior, and the impact of nanoparticles. The results of these studies indicate that *Pterophyllum scalare* possesses significant scientific potential for investigating various biological and ecological processes [9].

Thus, the freshwater angelfish occupies an important place as a reliable and informative model organism in both fundamental and applied biology, particularly in the fields of aquatic toxicology, ecotoxicology, and experimental zoology. Future studies conducted on this species are expected to provide significant results for the protection of aquatic ecosystems, the assessment of biological risks, and the development of new biotechnological approaches [10].

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CHEMICAL SCIENCES

SYNTHESIS OF ADAMANTYL AMIDOALKYL AGENTS AND NITROGEN HETEROCYCLES ON THEIR BASIS

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Abstract

Methods have been developed for the synthesis of adamantyl-containing amidoalkylating reagents: adamantyl-1-carboxy-N-(1-hydroxy-2,2,2-trichloroethyl)amide, adamantyl-1-carboxy-N-(1-chloro-2,2,2-trichloroethyl)amide, adamantyl-1-carboxy-N-(2,2,2-trichloroethylidene)amide, adamantyl-1-carboxy-N-(2,2-dichloro-1-cyanovinyl)amide, 2-(adamantyl-1-carboxamido)-3,3-dichloroacrylamide, and 2-(adamantyl-1-carboxamido)-3,3-dichloroacrylic acid. Using these reagents, 2-(adamantan-1-yl)-4-(dichloromethylene)oxazol-5(4H)-one and 2-(adamantan-1-yl)-4-(dichloromethylene)-1H-imidazol-5(4H)-one were obtained via cyclocondensations in 73% and 76% yields, respectively. All products were identified by IR and 1H NMR spectra.

Keywords: 2,2,2-trichloroacetaldehyde, adamantyl-1-carboxamide, amidoalkylating reagents, oxazoles, imidazoles, cyclocondensations.

Introduction

The chemistry of nitrogen heterocyclic derivatives has attracted the attention of many researchers. They are finding increasing application in the production of polymeric materials, dyes, pharmaceuticals, insecticides, herbicides, and plant growth regulators. Therefore, the search for new regioselective heterocyclizations based on readily available reagents is highly relevant. Such promising reagents include various amidoalkylating agents suitable for a number of characteristic cyclizations that cannot be achieved with aminoalkylating agents.

Preparation of Reagents. Typical amidoalkylating agents with the characteristic >C(OH)NHCOR fragment are usually prepared by reacting carboxylic acid amides, alkyl carbamates, and ureas with aldehydes, ketones, or α-dicarbonyl compounds [1-8].

Most aliphatic and aromatic aldehydes do not form stable N-1-hydroxyalkyl derivatives with amides. The stability of the latter is significantly increased by the introduction of electron-withdrawing substituents into the alkyl residue. The most important of these are the products of the reaction of chloral with primary amides of the general formula RCONHCH(OH)CCl3, which are readily formed by heating equimolecular quantities of the reagents without a catalyst or in the presence of sulfuric or hydrochloric acid [3].

Most of these condensation products have proven suitable for the preparation of even more pronounced amidoalkylating agents containing an N-1-chloroalkyl fragment. The latter react particularly readily with various nucleophiles, which is widely used for the synthesis of a number of N-alkylamide derivatives containing various oxygen-, nitrogen-, sulfur-, or phosphorus-containing functional groups at the α-position of the N-alkyl residue.

When considering the reactivity of amidoalkylating agents, their electrophilic nature should be taken into account first [4]. The lone electron pair of the nitrogen atom, although conjugated with the carbonyl group, still has a significant effect on the C–X bond (X = OH, Hal, and N-, S-, P-containing groups) due to the α-effect.

Intramolecular condensations. Cyclizations without the participation of an electrophilic center at position 1 of the N-alkyl fragment have been successfully achieved when the amidoalkylating agents contain one or two halogen atoms at position 2.

Easily accessible N-substituted amides of carboxylic and thiocarboxylic acids with the general formula CHCl2CH(X)NHC(Y)R undergo dehydrochlorination (dehydration) when treated with alkalis, alcoholates, or triethylamine, and are converted into oxazole, 2-oxazoline, or thiazole derivatives. Dehydration of synthons of the RC(O)NH-C(>C=)C(O)NHR' type, depending on their structure and condensation conditions, yields 2-imidazolin-5-one derivatives, which have been studied in greatest detail and are a convenient preparative method for the synthesis of substituted imidazolin-5-ones [5-17]. One of the simplest cases of such cyclization was discovered back in 1900 by E. Erlenmeyer during the treatment of amide of α-benzoylaminocinnamic acid with sodium hydroxide. However, acetic acid in the presence of sodium acetate was more often used as the condensing agent [11, 13-15].

Aim of the work. It is widely known that the presence of a framework fragment in a heterocycle exhibiting pharmacophoric properties often enhances these

properties. Therefore, the aim of this study was to introduce an adamantyl (framework) fragment into the heterocycle structure. At the initial stage of the study, as noted above, the use of adamantyl-1-carboxamide for the synthesis of the corresponding amidoacylating agent seemed the simplest.

Materials and methods

IR spectra were obtained on a Specord 75IR spectrometer for samples in KBr tablets containing 0.25% of the substance . 1H NMR spectra (400 MHz and 500 MHz) were taken on Varian Mercury-400 and Bruker Avance DRX 500 NMR spectrometers with TMS in accordance with the internal standard.

Mass spectra were obtained on a GCMS-TQ8040 Shimadzu instrument.

GLC analysis was carried out on a Tsvet-500 M device, glass column 1000x3 mm, 5% Apiezon L on Inerton N-AW-HMDS carrier, temperature 150-260 ºC (10 deg/min), carrier gas – helium (40 ml/min).

Adamantyl-1-carboxamide was obtained according to the method of [18].

Adamantyl-1-carboxy-N-(1-hydroxy-2,2,2-trichloroethyl)amide (3). [6]. A mixture of 0.2 mol of amide (1), 0.22 mol of chloral (2) and 1 ml of concentrated sulfuric acid is heated to boiling in 50 ml of chloroform and boiled for 6 hours. The formed precipitate after cooling the reaction mixture is filtered off, washed with benzene, water and dried in vacuo over P_2O_5. The yield of amide (3) is 87%. M.p. 154-155 °C (benzene). IR (KBr, cm^{-1}): 850 (C-Cl, ν), 1100 (C-O, ν), 1300 (OH, δ), 1570 (NH, δ), 1640 (C=O, ν), 2910 (CH, ν), 2840 (CH, ν), 3440 (NH, ν), 3625 (OH, ν). ^{1}H NMR (δ, ppm): 4.5 (OH, s, J=4.8 Hz), 7.3 NH, d, J=6.5 Hz), 7.6 (CH, m), 0-8-1.1 (15H, m). MS (*m/z*): 325 ($M^{\bullet+}$), 307, 289, 271, 135.

Adamantyl-1-carboxy-N-(1-chloro-2,2,2-trichloroethyl)amide (4). [19]. To a suspension of 0.05 mol of amide (3) in 50 ml of anhydrous CCl_4 is added 0.15 mol of $SOCl_2$ over 0.5 h. The mixture is stirred for another 1 h. The precipitate is separated, washed with CCl_4 and dried in vacuo. The yield of chloramide (4) is 89%. M.p. 171-172 °C (CCl_4). IR (KBr, cm^{-1}): 870 (C-Cl, ν), 970 (C-Cl, ν), 1130 (C-O, ν), 1290 (OH, δ), 1580 (NH, δ), 1650 (C=O, ν), 2830 (CH, ν), 2920 (CH, ν), 3450 (C-O, ν), 3640 (OH, ν). ^{1}H NMR (δ, ppm): 7.4 (NH, d, J=6.8 Hz), 6.2 (CH, d, J=6.8 Hz), 0.8-1.1 (15H). MS (*m/z*): 343 ($M^{\bullet+}$), 308, 307, 261, 135.

Adamantyl-1-carboxy-N-(2,2,2-trichloroethylidene)amide (5). [20]. A solution of 0.03 mol of triethylamine in 20 ml of benzene is added dropwise with stirring to a solution of 0.03 mol of amide (4) in 180 ml of benzene. After 30 min, the triethylamine salt is filtered off, and the benzene is removed in vacuo. The residue is crystallized from hexane-ethyl acetate (10:1). Yield of imine (5) 75%. M.p. 116-117 ºC. IR (KBr, cm^{-1}): 990 (C-Cl, ν), 1710 (C=O, ν), 2850 (CH, ν), 2890 (CH, ν). NMR ^{1}H (δ, ppm): 9.2 (CH, s), 0.8-1.1 (15H). MS (*m/z*): 307 ($M^{\bullet+}$), 225, 190, 135.

Adamantyl-1-carboxy-N-(2,2-dichloro-1-cyanovinyl)amide (6). [21]. A solution of 0.02 mol of amide (5) in 70 ml of ether is added dropwise over 0.5 h with vigorous stirring and ice-cooling to a mixture of 0.042 mol of triethylamine and 0.04 mol of hydrocyanic acid in 50 ml of ether. The mixture is stirred for 1 h at room temperature. The precipitate is filtered off and suspended in 100 ml of water. The insoluble portion is filtered off, washed with water, dried in vacuo over P_2O_5 and recrystallized from benzene. The yield of amide (6) is 73%. M.p. 121-122 °C (with decomposition). IR (KBr, cm^{-1}): 950 (C-Cl, ν), 1570 (NH, δ), 1645 (=C-CN, ν), 1660 (C=O, ν), 2210 (>N-C=C-CN, ν), 2840 (CH, ν), 2910 (CH, ν), 3440 (NH, ν). NMR ^{1}H (δ, ppm): 9.6 (NH, s), 0.8-1.1 (15H). MS (*m/z*): 332 ($M^{\bullet+}$), 250, 135, 42.

2-(Adamantyl-1-carboxamido)-3,3-dichloroacrylamide (7). [22]. To a suspension of 0.5 mol of nitrile (6) in 250 ml of 80% aqueous acetic acid solution, 1 mol of activated zinc dust is added in small portions over 3 hours with vigorous stirring at a mixture temperature not exceeding 40 °C. The mixture is kept under stirring for 5 hours, the zinc salts are filtered off and washed with acetic acid. The filtrate is evaporated in vacuo at 30-40 °C. The residue is triturated with water to obtain a crystalline mass. After filtration, the crystals are dried in vacuo over P2O5 and recrystallized from hexane-ethyl acetate (1:1). Yield 71%. M.p. 186-187 °C. IR (KBr, cm^{-1}): 780 (C=C-CCl2), 835 (C-Cl, ν), 929 (C-Cl, ν), 1660 (C=O, ν), 1677 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν), 3180 (NH, ν), 3350 (NH, ν), 3440 (NH, ν). ^{1}H NMR (δ, ppm): 8.3 (NH2, m), 10.1 (NH, s), 0.8-1.1 (15H). MS (*m/z*): 352 ($M^{\bullet+}$), 270, 135, 44.

2-(Adamantyl-1-carboxamido)-3,3-dichloroacrylic acid (8). [23]. A suspension of 0.3 mol of nitrile (6) in 800 ml of concentrated hydrochloric acid is quickly heated until the precipitate dissolves and boiled for 15-20 min. Cooled with ice. The precipitate is filtered off, washed with water and added in small portions to 1.5 l of saturated sodium bicarbonate solution. Shake the mixture until the evolution of carbon dioxide ceases. Filter to remove insoluble amide of acid (8). Acidify the filtrate with concentrated hydrochloric acid to pH ~ 2. The precipitate is filtered off, washed with water and dried in vacuo over P2O5. The yield of acid (8) is 62%. M.p. 195-196 ºC. IR (KBr, cm^{-1}): 950 (C-Cl, ν), 1635 (C=O, ν), 1640 (C=O, ν), 1715 (C=C-COOH, ν), 2840 (CH, ν), 2910 (CH, ν), 3300 (OH, ν). ^{1}H NMR (δ, ppm): 9.9 (NH, s), 12.8 (COOH, s), 0.8-1.1 (15H). MS (m/z): 353 ($M^{\bullet+}$), 336, 308, 271, 135, 45.

2-(Adamantan-1-yl)-4-(dichloromethylene)oxazol-5(4H)-one (9). a) To a solution of 0.01 mol of acid (8) in 50 ml of methylene chloride is added 0.015 mol of dicyclohexylcarbodiimide (DCC). The mixture is boiled for 5 hours. The mixture is cooled and filtered to remove the urea precipitate. The filtrate is evaporated in vacuo. The residue is crystallized from hexane – ethyl acetate (1:1). The yield of oxazole (9) is 76%. M.p. 147-148 °C. IR (KBr, cm^{-1}): 1240 (C-O, ν), 1700 (C=CCl_2, ν), 1820 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν). NMR ^{1}H (δ, ppm): 0.8-1.1 (15H). MS (*m/z*): 299 ($M^{\bullet+}$), 217, 135, 44, 42.

b) [24]. A solution of 0.03 mol of sodium methoxide in 5 ml of methanol is added to a solution of 0.01 mol of acid (8) in 30 ml of methanol. The mixture is kept at 20-25 °C for 10-12 days. Sodium chloride is filtered off. Methanol is removed in vacuo. To the residue are added 30 ml of water and ether. The aqueous layer

is additionally extracted twice with 50 ml of ether. The combined ether extracts are dried over sodium sulfate. The ether is removed in vacuo. The residue is crystallized from hexane – ethyl acetate (1:1). The yield of oxazole (9) is 53%. M.p. 148-149 °C. IR (KBr, cm^{-1}): 1240 (C-O, ν), 1700 (C=CCl_2, ν), 1820 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν). NMR ^1H (δ, ppm): 0.8-1.1 (15H). MS (*m/z*): 299 ($M^{\bullet+}$), 217, 135, 42, 44.

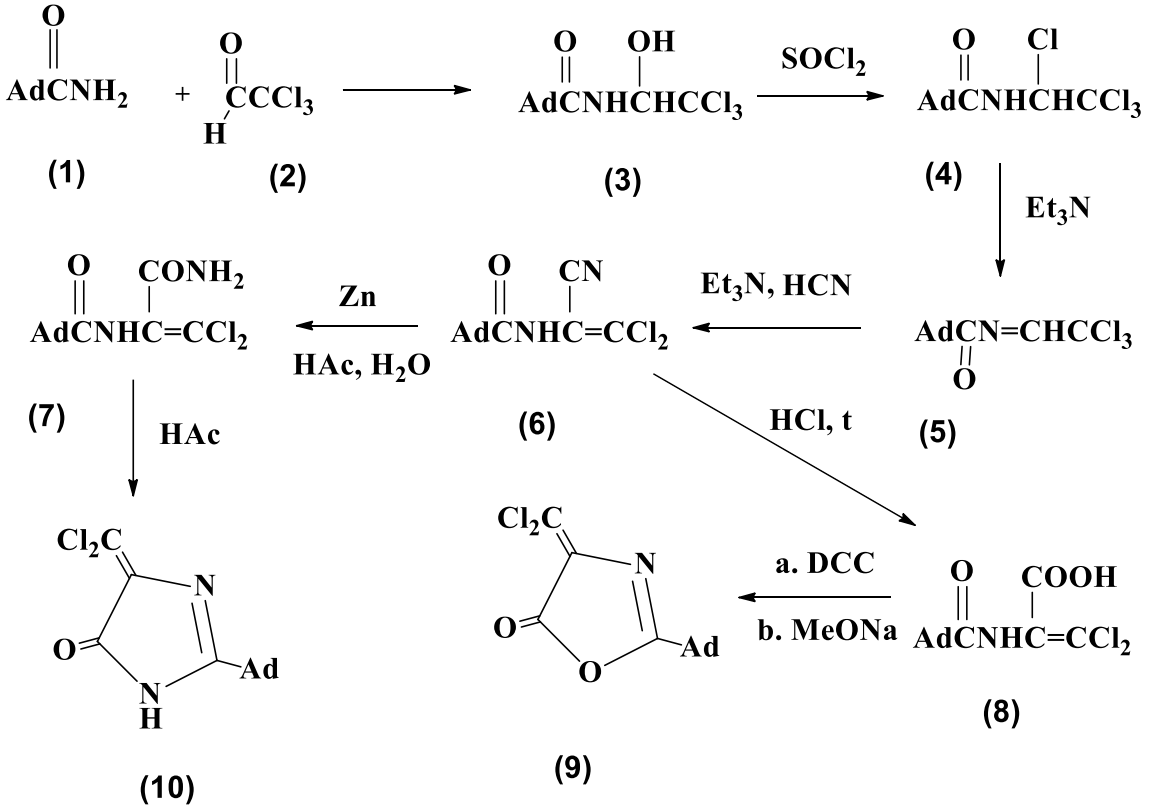
2-(Adamantan-1-yl)-4-(dichloromethylene)-1H-imidazol-5(4H)-one (10). [11] To a solution of 0.01 mol of amide in 30 ml of acetic acid was added 0.01 mol of sodium acetate. The mixture was heated at 60 °C for 7 hours. After cooling, the mixture was diluted with 100 ml of water and made alkaline with 10% NaOH solution. The solution was extracted with 3x50 ml of chloroform. Drying was performed over anhydrous sodium sulfate. The extract was evaporated. The residue was triturated with water until a crystalline mass was formed. Filtered and dried in vacuo over P2O5. The yield of imidazole (10) was 73%. M.p. 183-184 ºC. IR (KBr, cm^{-1}): 800 (NH, δ), 930 (C=CCl_2, ν), 1330 (C-N, ν), 1465 (NH, δ), 1715 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν). ^1H NMR (δ, ppm): 8.5 (NH, s), 0.8-1.1 (15H). MS (*m/z*): 298 ($M^{\bullet+}$), 297, 216, 135, 42, 27.

Results and discussion.

Synthesis of reagents. As can be seen from the scheme, to obtain the target heterocycles (9) and (10), it was necessary to go through several stages of synthesis of the starting reagents - acid (8) and amide (9), respectively. The first synthesis, common to both reagents, was the synthesis of adamantyl-containing amide (3). To obtain it, it was necessary to make changes to the original method [6], since amide (1) had limited solubility in benzene even when heated. The reaction was carried out in chloroform. The time was increased to 6 hours. Identification of product (3) was carried out based on the IR spectrum. The presence of characteristic deformation and stretching vibrations of NH, OH bonds, as well as stretching vibrations of C=O, C-Cl, CH bonds confirms the composition of amide (3). In addition, the PMR spectrum contains signals of NH and CHOH protons with characteristic shifts and splitting constants. The presence of the adamantyl fragment is confirmed by a multiplet integrating over 15 protons in the range of 0.8-1.1 ppm. The mass spectrum confirms the mass of the product and the presence of characteristic fragments formed by the elimination of water molecules, dichlorocarbene, and the adamantyl cation (*m/z* 135) [25]. The yield of amide (3) was 87%.

The next step was the conversion of the amido alcohol (3) to the amido chloride (4) [19]. For this, a suspension of the amide (3) in CCl_4 was treated with thionyl chloride. The yield of amide (4) was 89%. The structure of chloride (4) is confirmed by the following spectra: IR (KBr, cm^{-1}) 870 (C-Cl, ν), 970 (C-Cl, ν), 1130 (C-O, ν), 1290 (OH, δ), 1580 (NH, δ), 1650 (C=O, ν), 2830 (CH, ν), 2920 (CH, ν), 3450 (C-O, ν), 3640 (OH, ν). PMR (δ, ppm): 7.4 (NH, d, J=6.8 Hz), 6.2 (CH, d, J=6.8 Hz), 0.8-1.1 (15H). MS (*m/z*): 343 ($M^{\bullet+}$), 308, 307, 261, 135.

Imine (5) was obtained by treating a solution of chloride (4) in benzene with triethylamine [20]. The reaction proceeded at room temperature for 30 minutes, as evidenced by the precipitation of triethylamine hydrochloride. The yield of the product was 75%. The product was identified by IR (KBr, cm^{-1}): 990 (C-Cl, ν), 1710 (C=O, ν), 2850 (CH, ν), 2890 (CH, ν), PMR (9.2 (CH, s), 0.8-1.1 (15H)), and MS spectra (307 ($M^{\bullet+}$), 225, 190, 135).



Scheme 1. Synthesis of adamantyl impurities amidoalkyl agents and nitrogen heterocycles

The next step was the synthesis of the key product, nitrile (6), from which the starting compounds for the synthesis of heterocycles, amide (7) and acid (8), were obtained [21]. A solution of amide (5) in ether was added dropwise with cooling to a solution of triethylamine and HCN. The reaction mixture was kept at room temperature for 1 hour. As a result, nitrile (6) was formed in 76% yield. The structure was confirmed by IR, PMR and mass spectra. Thus, the IR spectrum contains characteristic signals of bond vibrations: stretching C-Cl at 950 cm^{-1}, =C-CN at 1645 cm-1, C=O at 1660 cm^{-1}, >N-C=C-CN at 2210 cm^{-1}, CH at 2840 and 2910, NH at 3440; deformation vibrations of NH at 1570 cm^{-1}. In the NMR spectrum, proton signals were observed: NH, a broad singlet at 9.6 ppm and 15 protons of the adamantane nucleus at 0.8-1.1. The mass spectrum showed a molecular ion mass of 298 m/z, which corresponds to the butto formula of compound (6), as well as fragment signals with masses of 297 (-$H^{\bullet}$), 216 (-CCl_2), 135 (Ad^+), 42 (NCO^+), 27 (CN^+).

Nitrile (6) is reduced to amide (7) according to the procedure described in [22]. As a result, amide (7) was obtained in 71% yield. The product was identified by IR, PMR, and mass spectra. IR (KBr, cm^{-1}): 780 (C=C-CCl_2), 835 (C-Cl, ν), 929 (C-Cl, ν), 1660 (C=O, ν), 1677 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν), 3180 (NH, ν), 3350 (NH, ν), 3440 (NH, ν). NMR ^1H (δ, ppm): 8.3 (NH_2, m), 10.1 (NH, s), 0.8-1.1 (15H). MS (*m/z*): 352 ($M^{\bullet+}$), 270, 135, 44.

The method of [23] was used to convert nitrile (6) to acid (8). The yield of product (8) was 62%. The standard set of signals in the IR, PMR, and mass spectra of acid (8), demonstrating its structure, is presented in the experimental section.

Synthesis of heterocycles. Two methods were used to synthesize oxazolone (9). The first was "traditional" and described in the article [24]. The synthesis involved treating acid (8) with sodium methylate in a methanol solution, followed by keeping the reaction mixture at room temperature for a long time. After isolation and purification of the product, the yield of oxazolone (9) was 53%. The IR, PMR, and MS spectra contained all the signals necessary to prove the structure. IR (KBr, cm^{-1}) : 1240 (C-O, ν), 1700 (C=CCl_2, ν), 1820 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν). The latter parameters indicated the presence of an adamantane ring in the product. The same is evidenced by the only proton signals in the ^1H NMR spectrum: 0.8-1.1 (15H). The mass spectrum shows the molecular mass of oxazolone (9) to be 299 D ($M^{\bullet+}$), a low-intensity molecular ion consistent with the molecular formula. Fragments corresponding to the leaving groups of CCl_2 (217 D), Ad (135 D), NCO (42 D), and CO_2 (44 D) are also visible.

The second method involved the use of dicyclohexylcarbodiimide (DCC) as a condensing agent in equimolar quantities. Product (9) was formed by refluxing the reagent mixture in methylene chloride. The yield of oxazolone (9) was significantly higher than in the first method, reaching 76%. The product had spectra similar to those of the product obtained in the first method.

Synthesis of imidazole (10) consisted of heterocyclization by means of intramolecular condensation of amide (7) [11]. The reaction took place in acetic acid medium in the presence of sodium acetate at 60 °C for 7 hours. Such prolonged heating was required to achieve the maximum degree of conversion – 73%. Identification of product (10) was carried out by means of IR and PMR spectroscopy, mass spectrometry. Thus, the following characteristic signals of bonds were observed in the IR (KBr, cm^{-1}): 800 (NH, δ), 930 (C=CCl_2, ν), 1330 (C-N, ν), 1465 (NH, δ), 1715 (C=O, ν), 2840 (CH, ν), 2910 (CH, ν). ^1H NMR spectroscopy revealed a broad singlet at 8.5 ppm, indicating the presence of a proton at the nitrogen atom. The presence of a group of signals at 0.8-1.1 ppm in the product, integrating on 15H, indicates the presence of a damantan substituent. The mass spectrum proved quite informative. The mass of the product, according to the MS spectrum, was 298 D, corresponding to the molecular formula $C_{14}H_{16}Cl_2N_2O_2$ and indicating the presence of two nitrogen atoms. The presence of fragments at 297, 216, 135, 42, and 27 D confirmed the imidazole structure (10).

Conclusions

1. Methods for producing adamantyl-containing amidoadkylating reagents in high yields have been developed.

2. Adamantylimidazole and adamantyloxazolone have been synthesized using adamantyl-containing amidoadkylating reagents.

3. Approaches for the synthesis of a variety of framework-containing nitrogen heterocycles have been discovered.

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ECONOMIC SCIENCES

MEASURES TO ENHANCE THE INVESTMENT APPEAL OF CONSTRUCTION COMPANIES

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Abstract

It has been established that the development of construction companies—as key economic entities influencing the operations of other firms—depends on the application of modern strategic tools, taking into account the influence of various stakeholder groups. There are certain issues concerning the operations of construction companies.

Of particular importance is overcoming the consequences of aggressive military operations. The scope and areas of application of strategic tools in construction enterprises are diminishing. The processes of improving the regulatory framework for investment attractiveness and stakeholder interaction require further refinement. A complex set of unresolved problems has made the research topic regarding the development of measures to ensure the growth of investment attractiveness of construction enterprises highly relevant.

As a result of the research, the objective of developing measures to ensure the growth of investment attractiveness of construction enterprises has been achieved.

Scientific and practical recommendations have been proposed for the development and implementation of a stakeholder-oriented strategy for enhancing the investment attractiveness of construction enterprises, based on the results of economic and mathematical modelling and forecasting, which has enabled the formulation of measures to boost investment attractiveness.

As a result of the study, theoretical approaches to identifying stakeholders of construction enterprises are proposed: functional, classificatory, transformational, systemic, evaluative and instrumental.

Keywords: investment attractiveness, construction companies, measures, stakeholders, strategy, practical recommendations.

Introduction. The development of construction companies, as key economic actors that influence the operations of other firms, depends on the application of modern strategic tools, taking into account the influence of various stakeholder groups. There are certain problematic issues regarding the operation of construction enterprises (CE). In particular, the directions for the formation and implementation of innovative processes in the construction sector are inadequately defined and supported. The factors of innovative development that influence the operation of construction enterprises are: ensuring the modernisation of fixed assets; the development of energy-saving technologies; the development and application of 'green' technologies; increasing working capital; improving the regulatory and legal framework for the development of the construction sector; financial support for the innovative activities of construction enterprises; the application of financial instruments and mechanisms for the development of innovative activities in construction enterprises; and the promotion of an innovation culture [1]. Of particular importance is overcoming the consequences of aggressive military operations. The scope and areas of application for strategic tools within construction enterprises are diminishing. Further refinement is required in the processes of improving the regulatory framework for investment attractiveness (IA) and stakeholder engagement. Consequently, a complex set of unresolved issues has made the topic of this study–concerning the development of measures to ensure the growth of investment attractiveness in construction enterprises–highly relevant.

Justification of existing theoretical approaches. The following types of stakeholders operating in the construction sector in accordance with the relevant regulatory framework have been identified: the client; the consulting engineer; people with reduced mobility; authorities responsible for urban planning;

state architectural and construction control and supervision bodies; bodies responsible for regulatory planning and land development; architectural and construction councils; clients commissioning urban planning documentation; technical administrator of the electronic system in the construction sector; stakeholders responsible for obtaining the information and/or documents required for the preparation of design documentation for the construction and/or technical upgrading of external power supply networks for the client's electrical installations (up to the connection point of the client's electrical installations) and design documentation for the construction of electrical networks for the linear section of the connection, and the specifics of approving such design documentation; owners or managers of construction sites; local authorities; other authorised bodies for urban planning and architecture; chief architects; creative unions of architects; self-regulatory organisations in the field of architectural activity; owners and users of architectural structures; construction companies – manufacturers of construction products; importers of construction products; distributors of construction products; the body responsible for determining technical acceptability; conformity assessment bodies; state market surveillance and state construction control bodies [2–4].

The investment climate is regarded as a comprehensive indicator of the state of enterprises in terms of growth prospects, return on investment and the level of investment risk, which motivates foreign investors to invest [5].

An instrumental approach to determining the investment attractiveness of enterprises has been implemented from the perspective of technologies, mechanisms and means of ensuring it [6].

The investment attractiveness of enterprises is influenced by factors relating to the investment climate: the political situation in the country; the level of economic stability; the regulatory framework governing investment activity; market conditions; the level of development of the domestic market; measures to ensure the efficient functioning of economic sectors; the extent of external influences; and the level of development of intellectual capital [5].

Building on the factor-based approach, investment attractiveness is characterised by factors that influence business operations: political and legal; economic; resource-related; infrastructure-related; market-related; competitive; stakeholder relations; technological; social [7].

The investment attractiveness of enterprises is characterised by their ability to attract investment resources of an appropriate volume and quality, and their capacity for simple and expanded reproduction, with a view to ensuring the sustainable development of production within a socially oriented market economy [8, p. 23].

The following characteristics of investment activities by construction companies have been identified: determining the areas of investment; the development and implementation of investment projects; identifying the parties involved in investment activities; the conduct of investment activities; ensuring state regulation of investment activities; safeguarding the rights of parties involved in investment activities; the liability of parties involved in investment activities; and determining the conditions for the termination of investment activities [9].

The following approaches to determining the investment potential of enterprises are described:

– identifying indicators for the quantitative assessment of investment attractiveness, taking into account static and dynamic characteristics;

– determining the state of investment activity, taking into account the level of investment attractiveness and activity;

– the intensity of investment activity;

– ensuring investment in production and business activities;

– characterisation of the enterprise's activities;

– the outcome of realising the enterprise's investment opportunities [10, p. 33].

The following classification criteria for a company's strategy have been identified, namely:

– areas of management and the specific features of its implementation;

– the company's operational life cycle;

– market behaviour; securing competitive advantages [11].

In addition, the following strategies are identified: corporate, business, functional and operational [12]. Depending on the approaches used to formulate the strategy and its functional purpose, they are classified as: global strategies, portfolio strategies and functional strategies [12]. It has been determined that a strategy needs to be developed to ensure the long-term operation of enterprises [13]. When formulating a development strategy for construction companies, account is taken of the specific characteristics of their operations and the impact of the construction sector [14, 15].

Consequently, in light of the above, the development of measures to enhance the investment attractiveness of construction companies requires a theoretical basis.

The aim of the study is to develop measures to enhance the investment attractiveness of construction companies.

Main section. The proposed measures to ensure the growth of the investment attractiveness of construction companies focus on increasing the following indicators:

– indicators characterising the impact of the consequences of hostilities on the functioning of construction companies and their participation in overcoming these consequences by 1% through;

– ensuring the completeness and accuracy of construction costs, establishing and maintaining databases of building standards, carrying out standardisation work in the construction sector during martial law, amending and implementing regional development programmes during martial law, amending urban planning documentation during martial law, identifying and taking into account the specific features of applying national standards for construction products, developing and implementing a programme for the comprehensive

restoration of the region or the territory of a local community (or part thereof), ensuring public consultation on draft comprehensive restoration programmes, providing compensation for damaged or destroyed immovable property, applying the procedure for compensation for destroyed immovable property, and compiling a register of damaged property, the effectiveness of construction companies' participation in overcoming the consequences of the Russian Federation's aggression, the application of a rapid response mechanism by the executive bodies of village, settlement and city councils, military administrations, central executive authorities, management bodies and civil protection forces, aimed at eliminating the consequences of the Russian Federation's armed aggression, improving the effectiveness of surveys of damaged properties, organisational and technical measures for preparing to conduct inspections, the commission inspection of damaged facilities by the authorised body, the completeness of documentary support for the dismantling of facilities, the organisation of operations to manage waste from destruction, ensuring the completeness of records of waste from destruction, and the implementation of operations to manage waste from destruction, taking into account the specific features of managing debris during site clearance, taking into account the specific features of managing debris during the dismantling of damaged (destroyed) structures, identifying temporary storage sites for debris, and identifying the specific features of reusing debris;

– indicators characterising the state and operational characteristics of the construction sector, and the economic trajectories of construction enterprises by bringing about fundamental changes in the following areas: the development of technical and organisational aspects of construction, the management of stakeholder interactions, the efficiency of housing construction, the promotion of innovative development in construction, the deregulation of construction activities, growth in construction output indices, total floor area of residential and non-residential buildings, capital investment volumes, current liquidity of the construction enterprises studied, financial autonomy, financial dependence, return on assets of the construction enterprises studied, capital intensity, the current ratio, and the return on net sales of construction products;

– stakeholder indicators by 2% through: improving the effectiveness of stakeholder analysis tools for construction enterprises, ensuring the typology of stakeholders, the effectiveness of stakeholder interaction strategies, and the level of interaction with construction clients, consulting engineers, and people with reduced mobility, authorities responsible for urban planning, state architectural and construction control and supervision bodies, bodies responsible for regulatory and legal planning and land development, architectural and construction councils, clients of urban planning documentation, technical administrators of the electronic system in the construction sector, and stakeholders which ensure the provision of information and/or documents necessary for the preparation of design documentation for the construction and/or technical upgrading of external power supply networks for the client's electrical installations (up to the point of connection of the client's electrical installations) and design documentation for the construction of the linear section of the connection, as well as the specifics of the approval of such design documentation, external owners or managers of construction sites, local authorities, other authorised bodies for urban planning and architecture, chief architects, creative associations of architects, self-regulatory organisations in the field of architectural activity, external owners and users of architectural structures, construction companies – manufacturers of construction products, importers of construction products, distributors of construction products, bodies responsible for determining technical acceptability, conformity assessment bodies, bodies responsible for state market surveillance and state construction control, central government bodies, local government bodies, organisations providing external information support to construction companies, social institutions, external financial institutions and organisations, external supervisory bodies (National Police of Ukraine, Security Service of Ukraine, Armed Forces of Ukraine, State Tax Service of Ukraine, State Customs Service, State Audit Service), other external stakeholders, internal representatives of construction company management bodies, internal owners of construction enterprises, construction enterprise workers, representatives of internal regulatory bodies of construction enterprises, internal financial departments of construction enterprises, representatives responsible for the formulation and implementation of construction enterprises' information policy, representatives responsible for the formulation and implementation of construction enterprises' social policy, and other internal stakeholders;

– indicators characterising the directions and specific features of investment activity, based on the implementation of fundamental changes achieved through: the development and implementation of a construction enterprise's development strategy; the comprehensive establishment of legal, financial, material and intellectual support; the development of programmes, projects and development plans; the building of investment capacity; the realisation of investment potential; monitoring, evaluation, adjustment of the implementation of investment projects, ensuring the investment activity of construction enterprises, and stakeholder engagement to support the investment activities of construction enterprises;

– environmental indicators with a 1% increase through: the participation of construction enterprises in state-funded and other environmental programmes, the observance of citizens' environmental rights, the impact of environmental protection management on the construction sector, the influence of environmental protection NGOs on the functioning of the construction sector, ensuring environmental monitoring for the functioning of the construction sector, taking into account the results of state registration of facilities that have a harmful impact on the state of the environment, utilising information on the state of the environment (environmental information), improving the level of environmental information provision in the construction sector, the use of environmental technologies at construction enterprises, compliance with environmental

standards at construction enterprises, ensuring environmental protection oversight for the operation of construction enterprises, ensuring public oversight in the field of environmental protection for the operation of construction enterprises, implementation of economic measures to ensure environmental protection for the operation of construction enterprises, funding of environmental protection measures for the operation of construction enterprises, ensuring environmental safety in the construction sector, effective management of construction waste, development and use of «green» construction tools, ensuring funding for mechanisms to support «green» construction, the level of support for «green» construction, ensuring the development of «green» construction, state regulation of «green» construction, determining compensation for environmental impact, state control, ensuring the certification of «green» construction projects, applying economic incentives for «green» construction, implementation of regional and local «green» construction programmes, participation of construction companies in regional and local «green» construction programmes, public awareness-raising regarding the development and implementation of regional and local «green» construction programmes, ensuring international cooperation in the field of «green» construction, green recovery, ensuring sustainability in the recovery process, ensuring sustainable (green) investment, the implementation of sustainable (green) recovery measures, governance in the recovery process, ensuring the recovery of individual sites and territories, state planning for «green» recovery, ensuring the monitoring of the implementation of «green» recovery programmes, the implementation of state policy in the field of ensuring the energy efficiency of buildings, information support for the energy efficiency of buildings, ensuring the energy efficiency of buildings, ensuring compliance with energy efficiency requirements for buildings at construction enterprises, the energy efficiency of buildings at construction enterprises, the effectiveness of energy audits of buildings at construction enterprises, the certification of persons intending to carry out energy efficiency certification activities, energy audits of buildings and inspections of technical installations, the effectiveness of self-regulatory organisations in the field of building energy efficiency, the effectiveness of building energy auditors, thermal modernisation and promotion of improved building energy efficiency, ensuring building energy efficiency through energy management systems, inspections of a building's technical installations, independent monitoring of energy certificates and reports on the results of inspections of technical installations, implementation of the National Plan to increase the number of buildings with near-zero energy consumption, development and implementation of a strategy for the thermal modernisation of buildings, provision of funding for thermal modernisation and energy efficiency measures, liability for breaches of legislation in the field of ensuring the energy efficiency of buildings;

– significant changes in ensuring the security of construction enterprises based on: the implementation of state policy in the fields of national security and defence; the impact of state policy in the fields of national security and defence on the functioning of construction enterprises; democratic civilian oversight; the provision of support to the security and defence sector; coordination in the fields of national security and defence; planning in the field of national security and defence; the implementation of the national security strategy, the implementation of the military security strategy, the implementation of Ukraine's public security and civil protection strategy, the implementation of the strategy for the development of Ukraine's defence-industrial complex, the implementation of Ukraine's cybersecurity strategy, the implementation of the strategy for integrated management of Ukraine's state border, the development of the national intelligence programme, the implementation of state programmes in the fields of national security and defence, financial support for the security and defence sector, economic, financial, information security, ensuring that the minimum subsistence level meets social standards, the realisation of the right to financial support in the event of unemployment and social services; vocational training or retraining, and professional development in institutions of vocational (vocational-technical), pre-higher and higher education, at construction enterprises; the provision to employers who employ citizens, in particular those with additional guarantees regarding employment assistance, of compensation in accordance with Article 26 of the Law of Ukraine «On Employment» at construction enterprises; the implementation of other social programmes at construction enterprises; the prevention of insured events; the effective management of unemployment insurance, ensuring supervision in the field of unemployment insurance, the formation and use of unemployment insurance funds, material support in the event of unemployment, ensuring the rights, duties and responsibilities of stakeholders when interacting with construction enterprises, pension provision, the formation and application of elements of the system and classification of social standards, the definition and application of state social standards and norms, the provision of state social guarantees, the financial provision for the implementation of state social standards, the provision of compulsory state social insurance, the rights, duties and responsibilities of stakeholders when interacting with construction companies in the field of compulsory compulsory state social insurance, improving the effectiveness of compulsory state social insurance against unemployment, compulsory state social insurance against accidents at work and occupational diseases resulting in loss of working capacity, ensuring control and supervision in the field of social insurance, social protection of labour veterans and other elderly citizens in Ukraine, social and legal protection of military personnel and their families, social protection of children of war, collection and accounting of the single contribution for compulsory state social insurance, state assistance to families with children, state social assistance to persons not entitled to a pension, and persons with disabilities, state social assistance to low-income families, state social assistance to persons with disabilities since childhood and children with disabilities, social protection of citizens affected by the Chernobyl disaster, social protection of homeless persons

and street children, and the provision of other social services;

– increasing the level of generation and utilisation of investment and innovation resources in construction enterprises through: the generation and utilisation of investment resources from domestic stakeholders in construction enterprises, the generation and utilisation of investment resources from foreign stakeholders in construction enterprises, ensuring state regulation in the field of innovation, the development and implementation of innovative projects, the development and use of innovative products, the effective operation of innovative enterprises, the provision of financial support for innovative activities at construction enterprises, international cooperation in the field of innovative activities, the formulation and implementation of strategic directions for the development of innovation, ensuring the monitoring of the implementation of priority areas of innovation, the functioning of the national innovation ecosystem, and the implementation of the strategy for the development of the innovation sector.

Conclusions. Scientific and practical recommendations are proposed for the development and implementation of a stakeholder-oriented strategy for enhancing the investment attractiveness of construction enterprises, based on the results of economic and mathematical modelling and forecasting, which has enabled the formulation of measures to increase the investment attractiveness of construction enterprises.

As a result of the study, theoretical approaches to identifying stakeholders of construction enterprises are proposed:

– functional: the directions and characteristics of interaction between construction enterprise stakeholders are identified;

– classification-based: the types of stakeholders of construction enterprises are characterised;

– transformational: changes occurring in the process of interaction between construction enterprise stakeholders are identified;

– systemic: stakeholders are considered as elements of a complex production and economic system of construction enterprise operations, whose interaction leads to positive changes and the development of construction enterprises;

– evaluative: focuses on methods and models for assessing the level of interaction among stakeholders in construction enterprises;

– instrumental: characterises the tools that facilitate interaction among stakeholders.

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ECONOMIC EFFICIENCY AND DEVELOPMENT TRENDS OF EDUCATIONAL TOURISM IN THE CONTEXT OF GLOBALIZATION

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Abstract

This study examines the economic efficiency and development trends of educational tourism in the context of globalization. The research highlights that educational tourism has evolved into a high value-added and knowledge-intensive sector that integrates the benefits of international education and tourism activities. Using a systematic analytical approach, the paper explores global growth dynamics over the period 2020–2025, identifies key drivers of expansion such as international student mobility, digital transformation, and cross-border academic cooperation, and evaluates the sector's structural role within the global tourism economy.

The findings indicate that educational tourism demonstrates strong resilience and a stable growth trajectory despite global disruptions, maintaining an average share of approximately 4–5% within total tourism while generating higher per capita expenditure and long-term economic benefits. Particular attention is given to the application of SWOT analysis as a strategic tool for assessing the economic efficiency of educational tourism, revealing critical strengths such as human capital development and high value-added services, alongside challenges related to infrastructure, global competition, and technological adaptation.

The study also considers the case of Uzbekistan, emphasizing its potential to develop educational tourism through cultural, pilgrimage, and academic integration, while addressing existing institutional and infrastructural constraints. The research concludes that improving the economic efficiency of educational tourism requires coordinated policy measures, investment in digital and physical infrastructure, diversification of tourism products, and the implementation of advanced measurement methodologies. Overall, the paper contributes to the theoretical and practical understanding of educational tourism as a key component of the global knowledge economy.

Keywords: Educational tourism, economic efficiency, globalization, tourism development trends, international student mobility, human capital, digital transformation, tourism competitiveness, SWOT analysis, globalization.

The rapid intensification of globalization has fundamentally reshaped the structure and dynamics of both the tourism and education sectors, giving rise to the increasingly significant phenomenon of educational tourism. In the contemporary knowledge-based economy, the integration of learning and mobility is no longer a supplementary activity but a strategic driver of human capital development, innovation diffusion, and cross-cultural competence. Educational tourism, which combines academic learning with experiential travel, has emerged as a critical mechanism through which countries enhance their global competitiveness, diversify tourism products, and strengthen international cooperation in education.

The relevance of this topic is further amplified by the accelerating scale and economic weight of the sector. According to recent global market analyses, the educational tourism market reached approximately USD 521.1 billion in 2025, reflecting its transformation into a major segment of the global tourism economy and highlighting its strong growth trajectory (MetaStat Insight, 2026). This expansion is closely linked to rising international student mobility, the growing demand for cross-border knowledge exchange, and the increasing importance of global skills in the labour market. At the same time, the broader tourism sector recorded 1.52 billion international tourist arrivals in 2025, indicating a full recovery and expansion of global mobility, which directly supports the development of educational travel formats (UN Tourism, 2025).

In the context of globalization, educational tourism serves multiple economic functions. It contributes to national income through export of educational services, stimulates local economies via student expenditures, and promotes long-term economic benefits through knowledge transfer and innovation. Moreover, it plays a vital role in shaping international academic networks and fostering intercultural understanding, which are essential in an increasingly interconnected world. The growing participation of not only students but also professionals, researchers, and policymakers in educational travel further underscores its expanding scope and multidimensional impact.

Additionally, the emergence of new technological trends such as digital learning platforms and hybrid educational models has redefined the structure of educational tourism, making it more accessible and diversified. At the same time, geopolitical, economic, and institutional factors continue to influence its development patterns, creating both opportunities and challenges for countries seeking to position themselves as educational tourism hubs.

Given these transformations, the study of the economic efficiency and development trends of educational tourism becomes particularly relevant. It allows for a deeper understanding of how educational tourism contributes to sustainable economic growth, how its efficiency can be measured, and how countries can strategically leverage globalization to enhance their position in this rapidly evolving sector.

The scholarly discourse on educational tourism has evolved significantly over the past two decades, reflecting its growing importance within the global tourism and education nexus. A number of researchers have contributed to conceptualizing, measuring, and evaluating the economic and developmental implications of educational tourism.

One of the foundational contributions is provided by Ritchie Brent W., whose work on tourism education and tourism as a system emphasizes the integration of learning experiences within tourism products. Ritchie's earlier studies argue that educational tourism enhances human capital formation and supports long-term destination competitiveness by linking experiential learning with economic value creation. His findings underline that destinations investing in education-oriented tourism products achieve more sustainable and knowledge-driven growth trajectories.

Similarly, Maga Adriana and Nicolau Juan L. (2018) explored educational tourism as a hybrid concept combining formal learning and travel experience. Their research demonstrates that educational tourism contributes not only to cognitive development but also to local economic stimulation through student expenditures and longer stays. The authors concluded that this form of tourism generates higher value-added compared to traditional leisure tourism due to its knowledge-intensive nature.

Further empirical insights are offered by Basri Muhammad (2023), who conducted a systematic literature review on English educational tourism and its economic impacts. The study revealed that educational tourism significantly contributes to the growth of small and medium-sized enterprises (SMEs), particularly in developing countries, by increasing demand for accommodation, language services, and local businesses. The findings also highlight that educational tourism serves as an effective tool for community empowerment and local economic diversification.

In addition, Meng Lin et al. (2024) examined the development of educational tourism in the context of intangible cultural heritage. Their study introduced a comprehensive evaluation framework using the Analytic Hierarchy Process (AHP) and identified key determinants such as educational value, cultural uniqueness, and infrastructure conditions. The results indicated that only a portion of cultural resources are suitable for educational tourism, and effective planning is required to balance preservation and economic utilization.

Another important contribution is made by Giampiccoli Andrea (2025), who focused on tourism education systems and curriculum development. His research proposed a general framework for tourism education, emphasizing the balance between theoretical knowledge and practical skills. The study concludes that a well-structured educational system is essential for supporting the long-term development of educational tourism by ensuring a skilled workforce and enhancing service quality.

Moreover, Andari Rini (2022) investigated the relationship between educational tourism and community-based ecotourism. The findings demonstrate that educational tourism can serve as a catalyst for sustainable development by promoting environmental awareness, community participation, and cultural preservation. The study highlights that integrating education into tourism activities enhances both social and economic outcomes at the local level.

Overall, the reviewed literature indicates that educational tourism is increasingly recognized as a multidimensional phenomenon that contributes to economic growth, human capital development, and sustainable tourism practices. However, existing studies also reveal several gaps, particularly in the measurement of economic efficiency and the integration of digital and globalized frameworks, which necessitate further research in this field.

In the context of globalization, educational tourism has emerged as a dynamic and high-value segment of the global economy, integrating the flows of knowledge, people, and capital across borders. The economic efficiency of educational tourism is increasingly recognized through its capacity to generate both direct and indirect economic benefits, including foreign exchange earnings, human capital development, innovation spillovers, and regional development. Unlike traditional tourism, educational tourism creates long-term economic value by combining consumption (tourism expenditure) with investment in human capital, thereby strengthening the knowledge-based economy. Empirical studies confirm that educational tourism has a statistically significant positive impact on economic growth, particularly when supported by strong institutional and technological environments (Astanakulov et al., 2024; based on threshold regression findings in multi-country analysis).

At the global level, the scale and growth dynamics of educational tourism clearly demonstrate its increasing economic importance. In 2025, the global educational tourism market reached approximately USD 519–521 billion, with projections indicating sustained double-digit growth rates exceeding 10–13% annually (Grand View Research, 2025; IMARC Group, 2025). This rapid expansion is driven by several globalization-related factors, including the internationalization of higher education, the rising demand for cross-cultural competencies, and the growing mobility of students and professionals. International student mobility, a key component of educational tourism, has grown from around 2.5 million in 2002 to nearly 6.9 million by 2022, with continued recovery and expansion observed in 2023–2025 (OECD data cited in recent market reports). These trends highlight the transformation of education into a globally traded service and position educational tourism as a major contributor to international service exports.

From an economic efficiency perspective, educational tourism is characterized by higher per-capita expenditure and longer duration of stay compared to conventional tourism segments. Students and educational travelers typically spend on tuition, accommodation, transportation, cultural activities, and local services, thereby stimulating multiple sectors of the host economy. In leading destinations such as the United Kingdom, international students accounted for over 685,000 individuals in the 2024/25 academic year, representing

a substantial contribution to local economies and service industries (HESA, 2025). Furthermore, globalization has intensified competition among countries to attract educational tourists, leading to the development of specialized policies such as scholarship programs, visa liberalization, and international academic partnerships.

In terms of development trends, the global educational tourism sector is increasingly shaped by digitalization, diversification, and sustainability. Hybrid learning models, virtual mobility, and digital platforms are expanding access to international education while simultaneously complementing physical mobility. At the same time, there is a growing shift toward thematic educational tourism, including language learning, cultural heritage education, environmental studies, and professional training programs. These trends reflect the broader transformation of tourism from a consumption-oriented activity into an experience-based and knowledge-intensive sector.

In the case of Uzbekistan, educational tourism is gaining strategic importance within the national tourism and education development agenda. The country's integration into global educational networks, expansion of international university partnerships, and increasing number of foreign students reflect a gradual but steady development of this sector. Uzbekistan's broader tourism growth also creates a favorable environment for educational tourism expansion. For instance, global tourism recovery trends such as the increase to approximately 1.45 billion international tourist arrivals in 2024 indicate a renewed global mobility environment that benefits emerging destinations, including Central Asian countries. In this context, Uzbekistan is actively positioning itself as a regional hub for cultural and educational tourism, particularly through initiatives in pilgrimage tourism, academic exchange programs, and the internationalization of higher education institutions.

Moreover, the economic efficiency of educational tourism in Uzbekistan can be linked to its potential to diversify the national economy, reduce dependence on traditional sectors, and enhance regional development. The country's rich historical and cultural heritage, combined with its expaning educational infrastructure, provides a strong foundation for integrating tourism and education. However, challenges remain, including the need for improved infrastructure, international accredtation, and digital integration. Addressing these issues is essential for maximizing the economic reurns of educational tourism in the context of globalization.

Overall, the analysis shows that educational tourism is evolving into a strategically imortant sector that contributes not only to economic growth but also to knowledge transfer, cultural echange, and sustainable development. Its economic efficiency is particularly evident in its multiplier effects, long-term benefits, and alignment with the demands of a globalized knowledge ecoomy.

In the context of globalization, the dynamics of educational tourism can be better understood through its growth trajectory and its relative share within the overall tourism economy. Over the period 2020–2025, the sector experienced a sharp pandemic-induced decline followed by a rapid recovery and stabilization phase. Analyzing these indicators allows for assessing not only the quantitative expansion of educational tourism but also its structural role in the global tourism market.

Table 1

Global Educational Tourism Growth and Share (2020–2025)

Indicators / Years	years					
	2020	2021	2022	2023	2024	2025
Market size (USD, billion)	320	290	360	420	459.8	519.9
Annual growth (%)	–25%	–9%	+24%	+17%	+9.5%	+13%
Global tourism size (USD, trillion)	4.7	5.8	7.6	9.5	10.8	11.7
Share in total tourism (%)	6.8%	5.0%	4.7%	4.4%	4.3%	4.4%

Source: MetaStat Insight (2026) Educational Tourism Market Size & Share Report, 2032.

The data clearly demonstrate that educational tourism underwent a V-shaped recovery pattern. In 2020–2021, the sector contracted significantly due to global mobility restrictions, with market size declining from approximately USD 320 billion to USD 290 billion. However, beginning in 2022, the sector entered a phase of rapid recovery, achieving a growth rate of over 24%, driven by the reopening of borders, the revival of international student mobility, and increased demand for cross-border education.

By 2024–2025, educational tourism reached a stable growth trajectory, with market volume expanding to nearly USD 520 billion. Despite this growth, its share within total tourism gradually decreased from 6.8% in 2020 to around 4.4% in 2025. This trend can be explained by the faster recovery of mass tourism segments compared to more specialized forms such as educational tourism.

At the same time, the relatively stable share of around 4–5% indicates that educational tourism maintains a consistent structural role in the global tourism economy. Importantly, this segment is characterized by higher per capita expenditure, longer duration of stay, and stronger multiplier effects, which enhance its overall economic efficiency compared to traditional tourism.

In the context of globalization, the economic efficiency of educational tourism cannot be fully understood without applying strategic analytical tools that capture both internal capacities and external dynamics. Among such tools, the SWOT framework (Strengths, Weaknesses, Opportunities, Threats) is particularly important because it allows researchers and policymakers to systematically evaluate the performance of educational tourism within a rapidly changing global environment.

Educational tourism operates at the intersection of two highly competitive global marketseducation and

tourism both of which are strongly influenced by technological change, international mobility, and institutional quality. Therefore, its economic efficiency is not determined solely by financial indicators such as revenue or contribution to GDP, but also by qualitative factors such as knowledge transfer, service quality, innovation capacity, and international competitiveness. SWOT analysis enables the integration of these multidimensional aspects into a single strategic framework, making it possible to identify efficiency drivers and structural constraints simultaneously.

From a methodological perspective, SWOT analysis is essential because it links micro-level factors (such as service quality, infrastructure, and institutional capacity) with macro-level processes (such as globalization, digitalization, and international competition). For instance, strong educational infrastructure and cultural attractiveness may increase the inflow of educational tourists, thereby enhancing export revenues and local economic activity. At the same time, weaknesses such as limited digital integration or insufficient international accreditation may reduce competitiveness and economic returns. Moreover, globalization creates new opportunities such as the expansion of cross-border education, online-offline hybrid learning models, and international partnerships while also intensifying risks related to global competition, geopolitical instability, and market volatility.

Thus, applying SWOT analysis in the study of educational tourism allows for a more comprehensive assessment of its economic efficiency by identifying how internal strengths can be leveraged to exploit external opportunities, while minimizing the impact of weaknesses and threats. This approach is particularly relevant for emerging destinations, including Uzbekistan, where strategic positioning in the global educational tourism market requires evidence-based decision-making.

Table 1

SWOT Analysis of Educational Tourism in the Context of Globalization

Strengths	**Weaknesses**
– High value-added sector (combines education + tourism expenditure)	– Limited international accreditation of institutions
– Longer duration of stay → higher per capita spending	– Lack of digital infrastructure in some regions
– Contribution to human capital development and innovation	– Lack of standardized measurement of efficiency
– Cultural and intellectual exchange enhances destination image	– Dependence on quality of educational services
Opportunities	**Threats**
– Growth of global student mobility and demand for international education	– Increasing global competition (UK, USA, EU, Asia hubs)
– Development of hybrid and digital learning tourism models	– Geopolitical instability affecting mobility flows
– Government support and international partnerships	– Economic crises reducing affordability of education abroad
– Expansion of niche segments (language, cultural, religious tourism)	– Rapid technological changes requiring continuous adaptation

The SWOT analysis demonstrates that educational tourism possesses strong structural advantages in terms of economic efficiency, particularly due to its high value-added nature and long-term benefits. However, its sustainability in the globalized environment depends on the ability of countries to address internal weaknesses especially in infrastructure and institutional quality while effectively leveraging emerging global opportunities. In this regard, SWOT analysis serves not only as an analytical tool but also as a strategic instrument for improving policy design, enhancing competitiveness, and ensuring sustainable development of educational tourism.

The analysis confirms that in the context of globalization, educational tourism has evolved into a strategically important and economically efficient sector that combines the benefits of international education and tourism. Its dual nature allows it to generate immediate economic returns through tourism expenditure while simultaneously producing long-term gains in the form of human capital development, knowledge transfer, and innovation diffusion. The global trends observed during 2020–2025 clearly indicate that despite external shocks such as the COVID-19 pandemic, educational tourism demonstrates strong resilience and a stable growth trajectory, supported by increasing international mobility, digital transformation, and the rising demand for global competencies.

At the same time, the study highlights that the economic efficiency of educational tourism is not automatic; it depends on a set of interconnected factors, including the quality of educational services, infrastructure development, institutional capacity, and integration into global networks. The SWOT analysis further reveals that while the sector has significant strengths and opportunities, it is also exposed to structural weaknesses and external risks, particularly in the areas of global competition, technological adaptation, and geopolitical uncertainty. For emerging destinations such as Uzbekistan, these challenges are accompanied by substantial untapped potential, especially in areas such as cultural, pilgrimage, and academic tourism.

From a policy and practical perspective, enhancing the economic efficiency of educational tourism requires a comprehensive and systematic approach.

Based on the findings of this study, the following recommendations are proposed:

First, it is essential to strengthen the integration between the education and tourism sectors by developing joint strategies, institutional coordination mechanisms, and integrated policy frameworks. This includes creating unified platforms for managing educational tourism flows, promoting academic mobility, and aligning tourism services with educational programs.

Second, countries should focus on improving the quality and international competitiveness of educational institutions, including expanding international accreditation, enhancing curriculum relevance, and increasing the number of programs offered in widely used global languages such as English. This will directly increase the attractiveness of the destination for international students and educational tourists.

Third, investment in infrastructure and digitalization should be prioritized. The development of smart tourism systems, digital learning platforms, and integrated service ecosystems (e.g., e-visa, online booking, educational platforms) will significantly improve accessibility, efficiency, and user experience.

Fourth, it is important to diversify educational tourism products by developing specialized segments such as language tourism, cultural and heritage education, short-term certification programs, and pilgrimage-based educational experiences. This diversification will allow destinations to capture different market niches and increase overall economic returns.

Fifth, governments should actively promote international partnerships and branding strategies. Collaboration with foreign universities, participation in global education networks, and targeted marketing campaigns will enhance visibility and competitiveness in the global market.

Finally, there is a need to develop advanced methodologies for measuring economic efficiency, including the use of composite indices (such as integrated efficiency indices), econometric models, and Tourism Satellite Account (TSA) frameworks. This will provide a more accurate assessment of the sector's contribution to the economy and support evidence-based decision-making.

In conclusion, educational tourism represents a high-potential sector within the globalized economy, capable of contributing to sustainable economic growth and international integration. However, realizing this potential requires strategic planning, institutional reforms, and continuous adaptation to global trends. For Uzbekistan and similar emerging economies, leveraging these opportunities can significantly enhance their position in the global educational tourism market while ensuring long-term socio-economic benefits.

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MODERN APPROACHES AND TRENDS IN FINANCIAL MANAGEMENT OF ENTERPRISES IN THE DIGITAL ECONOMY

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Abstract

This study explores modern approaches and emerging trends in financial management of enterprises in the digital economy. Particular attention is paid to the transformation of financial management systems under the influence of digital technologies, including automation, big data analytics, and cloud computing.

The research is based on analytical and comparative methods, which allow identifying key factors influencing enterprise performance and financial efficiency. The findings indicate that the integration of digital tools with traditional financial management practices significantly enhances decision-making processes, improves operational efficiency, and strengthens enterprise competitiveness.

The study highlights the importance of adopting innovative financial strategies and digital solutions to ensure sustainable development in a rapidly changing economic environment.

Keywords: financial management, digital economy, enterprise, financial analysis, digital transformation

1. Introduction

In the modern global economy, enterprises operate in an environment characterized by rapid technological advancement, increasing globalization, and intensified competition. These factors significantly influence the structure and functioning of financial management systems. As a result, enterprises must continuously adapt their financial strategies to maintain competitiveness and ensure sustainable development.

Financial management has evolved from a traditional function focused on accounting and control into a strategic tool that supports decision-making, risk management, and long-term planning. It plays a critical role in ensuring the efficient allocation of financial resources, optimizing costs, and maximizing profitability.

One of the most significant factors influencing modern financial management is digital transformation. The introduction of advanced technologies such as artificial intelligence, big data analytics, and cloud computing has fundamentally changed financial processes. These technologies allow enterprises to process large volumes of data, improve forecasting accuracy, and make more informed decisions.

Furthermore, digitalization has increased the importance of real-time financial information. Enterprises are now able to monitor financial performance continuously and respond quickly to market changes. This has led to a shift from reactive financial management to proactive and predictive approaches.

Another important aspect is the increasing complexity of financial systems. Enterprises must deal with various financial risks, including market volatility, currency fluctuations, and regulatory changes. Effective financial management requires the use of advanced analytical tools and strategic approaches to mitigate these risks.

Thus, the study of modern approaches and trends in financial management is highly relevant and necessary for understanding how enterprises can adapt to the challenges of the digital economy.

2. Literature Review

The development of financial management has been widely examined in economic literature, with particular emphasis on its transformation under the influence of globalization and digitalization. Traditionally, financial management focused on accounting, budgeting, and financial control; however, modern approaches extend beyond these functions to include strategic planning, risk management, and the use of digital technologies.

According to Atrill and McLaney [1], financial accounting serves as the foundation for effective managerial decision-making, as it provides reliable and structured information about enterprise performance. This information enables managers to evaluate financial results and develop appropriate strategies for future growth.

Brigham and Ehrhardt [2] emphasize that financial management is closely linked to financial policy, which determines how enterprises allocate resources, manage

risks, and achieve long-term sustainability. Their research highlights that well-designed financial policies contribute to increasing enterprise value and improving competitiveness in dynamic market conditions.

Gitman and Zutter [3] underline the importance of financial analysis and performance evaluation. They argue that enterprises actively applying financial indicators such as profitability, liquidity, and efficiency ratios demonstrate higher resilience and adaptability to economic changes.

In recent years, a growing number of studies have focused on the role of digital transformation in financial management. Laudon and Laudon [4] note that modern information systems significantly enhance financial data processing and analytical capabilities. Digital technologies allow enterprises to process large volumes of information, identify patterns, and improve the accuracy of forecasting and decision-making.

Similarly, Van Horne and Wachowicz [5] stress the importance of strategic financial management in a rapidly changing economic environment. They argue that enterprises must adopt flexible financial strategies and integrate innovative tools to remain competitive.

In the context of Azerbaijan, several studies highlight the sectoral characteristics influencing financial management practices. In particular, research on the development of light industry indicates that while certain segments have experienced growth, others remain unstable due to structural and external economic factors. For example, during the period 2018–2022, an overall increase in production was observed in garment manufacturing, leather processing, and footwear production, whereas textile production showed fluctuating dynamics. A SWOT analysis of the sector reveals both internal strengths, such as resource availability and labor potential, and existing challenges related to investment and technological development [Mammadova et al., 2022].

At the same time, modern research emphasizes the increasing role of advanced technologies such as artificial intelligence, big data analytics, and cloud computing in transforming financial management systems. These technologies contribute to improving efficiency, reducing operational costs, and enabling real-time decision-making.

Despite these advancements, several challenges remain, including the need for significant investments in digital infrastructure, the shortage of qualified specialists, and concerns related to data security.

Thus, the literature suggests that contemporary financial management represents a complex and multidimensional system that integrates traditional financial principles with innovative technological solutions and sector-specific factors.

3. Methodology

The methodological framework of this study is based on a systematic combination of analytical, comparative, and empirical approaches aimed at evaluating financial management practices in the digital economy. The selected methodology ensures a comprehensive and objective assessment of enterprise performance and financial efficiency.

The analytical approach is used to evaluate key financial indicators, including profitability, liquidity, and financial stability. These indicators allow for a quantitative assessment of enterprise performance and provide insights into the effectiveness of financial management systems.

The comparative method enables the analysis of differences between traditional and digital financial management approaches. In particular, the study examines how digital technologies improve financial processes, enhance data accuracy, and support real-time decision-making.

In addition, the empirical component of the research is based on the observation of industry trends and the analysis of financial performance indicators. This allows for identifying practical relationships between financial management tools and enterprise outcomes.

To ensure a structured analysis, the study applies a set of key financial indicators presented in Table 1.

Table 1.

Key indicators used in financial management analysis

Indicator	Description	Purpose
ROA (Return on Assets)	Measures efficiency of asset use	Performance evaluation
ROE (Return on Equity)	Measures return on shareholder capital	Profitability analysis
Current Ratio	Measures short-term liquidity	Solvency assessment
Debt-to-Equity Ratio	Measures financial leverage	Risk evaluation
Asset Turnover	Measures efficiency of asset utilization	Operational efficiency

These indicators form the basis for evaluating financial performance and identifying trends in enterprise development.

In addition, the research model used in the study is presented in Figure 1.

Figure 1. Research model of financial management evaluation

The proposed model demonstrates the relationship between financial management components and enterprise performance. It highlights the role of digital technologies in improving financial efficiency and decision-making processes.

4. Theoretical Foundations of Financial Management

Financial management is a fundamental component of enterprise management that focuses on the efficient allocation and use of financial resources. It encompasses a wide range of activities, including financial planning, analysis, control, and decision-making.

The primary objective of financial management is to maximize enterprise value while ensuring financial stability and minimizing risks. This requires a balanced approach that integrates both short-term operational decisions and long-term strategic planning.

Financial decisions are generally classified into three main categories:

- investment decisions;
- financing decisions;
- dividend decisions.

Investment decisions involve the allocation of capital to projects that generate future returns. These decisions require careful evaluation using methods such as net present value (NPV), internal rate of return (IRR), and payback period.

Financing decisions focus on determining the optimal capital structure. Enterprises must balance the use of equity and debt to minimize the cost of capital and reduce financial risk.

Dividend decisions relate to the distribution of profits among shareholders. Enterprises must decide whether to distribute profits or reinvest them in business development.

To better understand the structure of financial management, its main components are summarized in Table 2.

Table 2.

Components of financial management system

Component	Description	Role
Financial Planning	Forecasting financial needs	Strategic direction
Financial Analysis	Evaluation of performance	Decision support
Financial Control	Monitoring financial activities	Risk reduction
Risk Management	Identification and mitigation of risks	Stability

In the modern digital economy, financial management is increasingly influenced by technological innovations. Digital tools such as enterprise resource planning (ERP) systems, artificial intelligence, and data analytics significantly enhance financial processes.

The integration of these technologies improves data accuracy, reduces operational costs, and enables real-time monitoring of financial performance.

The conceptual structure of modern financial management is illustrated in Figure 2.

Figure 2. Structure of modern financial management system

Thus, financial management should be viewed as an integrated system that combines traditional financial principles with modern technological solutions. This integration is essential for improving efficiency, enhancing competitiveness, and ensuring sustainable enterprise development..

5. Financial Management Framework

The financial management framework represents a structured system of principles, methods, and tools used by enterprises to manage financial resources effectively. It integrates strategic and operational elements to ensure both short-term efficiency and long-term sustainability.

At the strategic level, financial management focuses on defining long-term objectives, determining investment priorities, and ensuring optimal capital allocation. Strategic decisions are closely linked to the overall goals of the enterprise and require a comprehensive analysis of internal and external factors.

At the operational level, financial management involves day-to-day activities such as budgeting, cost control, and financial reporting. These activities ensure the smooth functioning of the enterprise and support the implementation of strategic decisions.

A key element of the financial management framework is capital structure management. Enterprises must determine the optimal balance between equity and debt financing in order to minimize the cost of capital and reduce financial risks. An efficient capital structure enhances financial stability and increases enterprise value.

Another important component is financial planning, which involves forecasting future financial needs and developing strategies to meet them. Financial planning helps enterprises allocate resources efficiently and avoid potential financial difficulties.

Risk management is also an integral part of the framework. Enterprises face various financial risks, including market risk, credit risk, and liquidity risk. Effective risk management requires the identification, assessment, and mitigation of these risks through appropriate strategies.

In the digital economy, the financial management framework is increasingly influenced by technological innovations. Digital tools enable automation of financial processes, improve data accuracy, and enhance decision-making capabilities.

Thus, the financial management framework can be considered as an integrated system that combines strategic planning, operational control, and technological innovation to achieve enterprise objectives.

6. Financial Performance Analysis

Financial performance analysis is a critical component of financial management, as it allows enterprises to evaluate their efficiency and identify areas for improvement. It involves the use of various financial indicators that provide insights into different aspects of enterprise performance.

Profitability analysis focuses on the ability of an enterprise to generate income from its operations. Indicators such as return on assets (ROA) and return on equity (ROE) are widely used to measure profitability. A higher ROA indicates more efficient use of assets, while ROE reflects the return generated for shareholders.

Liquidity analysis evaluates the ability of an enterprise to meet its short-term obligations. The current ratio and quick ratio are commonly used indicators. Maintaining an optimal level of liquidity is essential for ensuring financial stability and avoiding solvency problems.

Efficiency analysis examines how effectively an enterprise utilizes its resources. Indicators such as asset turnover ratio provide insights into operational efficiency. Higher efficiency indicates better utilization of resources and improved performance.

In addition to individual indicators, integrated financial analysis combines multiple indicators to provide a comprehensive assessment of enterprise performance. This approach allows managers to identify relationships between different aspects of financial activity and make more informed decisions.

To illustrate the structure of financial performance analysis, Table 3 presents the main categories of indicators.

Table 3.

Structure of financial performance analysis

Category	Indicators	Purpose
Profitability	ROA, ROE	Measure income generation
Liquidity	Current ratio, Quick ratio	Assess short-term solvency
Efficiency	Asset turnover	Evaluate resource use
Stability	Debt ratio	Measure financial risk

The analysis of these indicators provides valuable insights into enterprise performance and helps identify strengths and weaknesses.

In the context of digital transformation, financial performance analysis has become more advanced and data-driven. Modern analytical tools enable real-time monitoring of financial indicators and improve the accuracy of analysis.

7. Advanced Financial Analysis

Advanced financial analysis represents a higher level of evaluating enterprise performance, where traditional financial indicators are complemented by dynamic analytical approaches and forecasting techniques. In modern financial management, enterprises are no longer limited to the use of static indicators but increasingly rely on comprehensive analytical systems that provide deeper insights into financial processes.

One of the fundamental components of advanced analysis is ratio analysis, which evaluates profitability, liquidity, and efficiency. However, in contemporary practice, these indicators are interpreted in a broader analytical context, taking into account their interaction and long-term trends.

Trend analysis plays a significant role in understanding the development of financial indicators over time. By examining changes in revenue, costs, and profitability, enterprises can identify underlying patterns and assess the stability of their financial performance. A consistent upward trend may indicate sustainable growth, while fluctuations or declines may signal inefficiencies or external pressures.

Forecasting is another essential element of advanced financial analysis. It involves the use of statistical and analytical methods to predict future financial outcomes. Techniques such as regression analysis and time-series forecasting allow enterprises to anticipate potential risks and opportunities. This forward-looking approach enhances the quality of financial planning and supports more informed decision-making.

Scenario analysis further strengthens the analytical framework by allowing enterprises to evaluate possible outcomes under different conditions. By considering optimistic, pessimistic, and realistic scenarios, managers can better prepare for uncertainty and develop flexible strategies.

Overall, advanced financial analysis enhances the ability of enterprises to understand complex financial relationships, improve forecasting accuracy, and make strategic decisions that support long-term development.

8. Digital Transformation in Financial Management

Digital transformation has become a defining feature of modern financial management, significantly influencing how enterprises organize, analyze, and control their financial activities. The integration of digital technologies has shifted financial management from traditional, manual processes to automated and data-driven systems.

One of the key aspects of digital transformation is the automation of financial processes. Automated systems reduce the need for manual intervention, minimize errors, and increase the speed and efficiency of financial operations. As a result, enterprises are able to process large volumes of financial data more effectively and ensure greater accuracy in reporting.

Artificial intelligence has emerged as a powerful tool in financial management. AI-based systems are capable of analyzing complex datasets, identifying patterns, and generating predictive insights. This enhances the quality of financial analysis and supports more accurate decision-making.

Big data analytics further expands the capabilities of financial management by enabling the processing of large and diverse datasets. Enterprises can analyze financial and operational information simultaneously, gaining deeper insights into performance and identifying hidden relationships between variables.

Cloud computing also plays a significant role in modern financial systems. It provides flexible and scalable solutions for data storage and processing, allowing enterprises to access financial information in real time. This improves collaboration between departments and enhances the overall efficiency of financial management.

Despite its advantages, digital transformation presents several challenges. The implementation of ad-

vanced technologies requires significant financial investment and skilled personnel. In addition, issues related to data security and privacy must be carefully managed to ensure the reliability of financial systems.

In general, digital transformation contributes to improving the efficiency, transparency, and adaptability of financial management. Enterprises that successfully integrate digital technologies into their financial systems are better positioned to respond to market changes and achieve sustainable growth.

9. Empirical / Practical Analysis

Empirical analysis plays a crucial role in evaluating the real impact of financial management practices on enterprise performance. In the context of the digital economy, practical observations indicate that enterprises implementing modern financial management systems demonstrate significantly higher efficiency and competitiveness compared to those relying on traditional approaches.

One of the key findings of empirical observations is that digitalization contributes to improving financial transparency and control. Enterprises that adopt automated accounting systems and digital financial tools are able to monitor their financial activities in real time, which enhances the accuracy of reporting and reduces the likelihood of errors.

In addition, empirical evidence suggests that the use of advanced financial analysis techniques leads to better decision-making outcomes. Enterprises that actively apply forecasting methods and analytical tools are more capable of anticipating market changes and adjusting their strategies accordingly. This results in improved financial stability and reduced operational risks.

Another important aspect revealed through practical analysis is the relationship between digital transformation and cost efficiency. The implementation of digital financial systems reduces administrative costs by automating routine processes and minimizing the need for manual intervention. This allows enterprises to allocate resources more efficiently and focus on strategic activities.

Furthermore, empirical observations highlight the importance of integrating financial management with other business functions. Enterprises that combine financial data with operational and strategic information achieve a more comprehensive understanding of their performance and are better equipped to identify opportunities for growth.

Thus, empirical analysis confirms that the adoption of modern financial management approaches, particularly those based on digital technologies, has a positive impact on enterprise performance, efficiency, and long-term sustainability.

10. Discussion

The results of this study demonstrate that financial management has evolved into a complex and multidimensional system that integrates traditional financial principles with modern technological solutions. The findings highlight the importance of adopting a holistic approach to financial management in order to achieve sustainable enterprise development.

One of the key insights is that digital transformation plays a central role in enhancing financial management efficiency. The use of digital tools improves data accuracy, accelerates financial processes, and supports real-time decision-making. This allows enterprises to respond more effectively to changing market conditions and maintain competitiveness.

At the same time, the study reveals that financial management effectiveness depends not only on the use of advanced technologies but also on the quality of financial strategy and organizational capabilities. Enterprises must develop clear financial policies, invest in human capital, and ensure the proper implementation of digital systems.

Despite the advantages of modern financial management approaches, several challenges remain. These include the high cost of digital transformation, the need for qualified personnel, and concerns related to data security. Addressing these challenges requires coordinated efforts from enterprises, policymakers, and educational institutions.

The discussion also emphasizes the importance of continuous innovation in financial management. As the business environment becomes more dynamic, enterprises must adopt flexible and adaptive strategies that allow them to respond to emerging risks and opportunities.

Overall, the findings suggest that the integration of financial management with digital technologies and strategic planning is essential for achieving long-term success in the digital economy.

11. Conclusion

In conclusion, financial management represents a fundamental component of enterprise success in the modern digital economy. The transformation of financial management systems under the influence of digital technologies has significantly improved the efficiency and effectiveness of financial processes.

The study demonstrates that the integration of financial accounting, strategic financial management, and digital tools enhances decision-making, improves financial control, and strengthens enterprise competitiveness. Enterprises that adopt modern financial management approaches are better positioned to achieve sustainable growth and adapt to changing market conditions.

Furthermore, the research highlights the importance of advanced financial analysis and digital transformation in improving enterprise performance. The use of forecasting techniques, data analytics, and automated systems allows enterprises to make more accurate and timely decisions.

At the same time, the successful implementation of modern financial management systems requires overcoming several challenges, including technological complexity, investment costs, and the need for skilled personnel. Addressing these challenges is essential for maximizing the benefits of digital transformation.

Future research should focus on the empirical evaluation of digital financial tools, the development of innovative financial models, and the analysis of indus-

try-specific financial management practices. Such studies will contribute to a deeper understanding of financial management in the digital economy and support the development of more effective strategies.

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN IMPROVING THE QUALITY OF SERVICE IN THE FIELD OF TOURISM

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Abstract

This article provides a comprehensive analysis of the role of artificial intelligence technologies in improving service quality in the tourism sector. The study covers the main capabilities of artificial intelligence, including service personalization, automation, predictive analytics, and customer feedback analysis. It also examines the impact of modern solutions such as chatbots, virtual assistants, dynamic pricing, and automated booking systems on the efficiency of tourism services.

The article also analyzes the example of the Uzbek tourism market and substantiates the importance of introducing artificial intelligence technologies in the context of growing tourist flows and increasing demand for services. At the same time, it is noted that the implementation of these technologies in local conditions is directly related to infrastructure, digital literacy, and personnel training.

The results of the study show that artificial intelligence is of strategic importance in improving service quality, effective resource management, and customer satisfaction in the tourism sector. The conclusions presented in the article confirm the increasing role of artificial intelligence technologies in the process of digital transformation of the tourism industry.

Keywords: Artificial intelligence, tourism industry, service quality, personalized services, automation, chatbots, virtual assistants, predictive analytics, customer sentiment analysis, smart tourism, digital transformation, Uzbek tourism, Big Data in tourism.

In recent years, artificial intelligence (AI) has become one of the most important innovative technologies in the tourism industry. Its implementation allows to improve the quality of tourist services, better understand customer needs and optimize service processes. In today's digital era, tourists are in need of fast, convenient and personalized services, which requires the widespread use of artificial intelligence technologies in the tourism industry.

In Uzbekistan, the tourism sector has also been developing rapidly in recent years and is becoming one of the priority sectors of the country's economy. According to the National Statistics Committee, in 2025, a total of 11.7 million foreign citizens visited Uzbekistan for tourism purposes, which is an increase of 3.7 million people or 46.8% compared to the previous year. At the same time, 7.6 million Uzbek citizens traveled to foreign countries for tourism purposes in 2025, which also increased by 22.2% (National Statistics Committee of the Republic of Uzbekistan, 2025).

One of the most important advantages of artificial intelligence is its ability to personalize services. AI systems analyze large amounts of data and provide tourists with tailored offers based on their interests, previous travel experiences, and online activities. This significantly increases customer satisfaction and takes the quality of tourism services to a new level (Miró & García, 2024). Also, chatbots and virtual assistants based on artificial intelligence improve service quality by providing 24/7 service to tourists and providing quick responses (Zaman, 2025).

In addition, artificial intelligence plays an important role in increasing operational efficiency in the tourism sector. By automating reservation systems, route planning, and customer communication processes, human errors are reduced and service delivery is faster. AI technologies also enable the forecasting of demand and supply, which helps to allocate resources more efficiently.

In general, artificial intelligence is of strategic importance in improving the quality of service in the tourism sector, which not only improves the customer experience, but also makes a significant contribution to the development of the entire industry. From this point of view, in the context of the rapid growth of the tourism sector in Uzbekistan and the increasing flow of tourists, the effective use of artificial intelligence technologies is one of the important factors in improving the quality of service and increasing the competitiveness of the national tourism industry.

Research on the role of artificial intelligence in improving service quality in tourism shows that this technology is fundamentally changing the industry. The main focus in the literature is on the impact of AI in areas such as personalization of services, increasing operational efficiency, improving service quality and marketing strategies.

A number of studies have shown that artificial intelligence significantly increases customer satisfaction by personalizing tourism services. AI systems analyze tourists' interests, travel history and behavior and provide them with appropriate recommendations. This allows tourism products and services to be presented more effectively (Miró & García, 2024; Doğana & Niyet, 2024). At the same time, the possibility of providing real-time service through chatbots and virtual assistants is taking service quality to a new level (Zaman, 2025).

The second important direction of AI is noted in scientific sources as increasing operational efficiency. Automated reservation systems, route planning and

customer service processes reduce the human factor, increase the speed and accuracy of service. Also, through predictive analytics, resources are allocated more efficiently and economic results are improved (Lina & Talukder, 2024; Pandey et al., 2025).

Other studies emphasize the importance of sentiment analysis in improving the quality of artificial intelligence services. Through this technology, travel companies can analyze customer opinions and continuously improve services (Sankar & David, 2023). AI also plays an important role in marketing and route management, strengthening customer relationships and increasing brand loyalty (Sharma, 2024; Ma et al., 2025).

However, the scientific literature also highlights a number of problems associated with the introduction of artificial intelligence. These include high costs, data security, ethical issues, and the lack of transparency of algorithms (Wang et al., 2025). Therefore, some researchers emphasize the need for a cautious and gradual approach to the introduction of AI.

From a scientific point of view, while some foreign studies assess AI as the main factor that significantly increases the quality of tourism services, in our opinion, the effectiveness of this technology in the conditions of Uzbekistan is directly related to the level of infrastructure, personnel training, and digital literacy. Therefore, it is important to take into account local conditions when introducing AI.

Uzbek scientists are also conducting a number of studies to study the possibilities of digital technologies and artificial intelligence in the tourism sector. In particular, studies conducted by Abdurakhmonova, Astanakulov, Goyipnazarov and Irmatova have emphasized that Industry 4.0 technologies, including artificial intelligence, the Internet of Things (IoT) and digital platforms, are an important factor in the modernization of tourism services within the framework of the Tourism 4.0 concept (Abdurakhmonova et al., 2023). These studies have shown that the introduction of "smart tourism" systems using intelligent technologies creates the opportunity to improve service quality and optimize tourism processes. Also, according to the results of a study conducted by Astanakulov, Balbaa, Foziljonov and Batirova, artificial intelligence technologies are important in improving digital marketing strategies, which increase the effectiveness of promoting tourism services and expand the possibilities of establishing effective communication with customers (Astanakulov et al., 2024).

In general, the literature review confirms that artificial intelligence is versatile and strategic in improving service quality in the tourism sector, but it is also emphasized that its effective use depends on the level of economic and technological development of each country.

Artificial intelligence is one of the most effective tools for improving the quality of service in the tourism sector. According to scientific literature, AI technologies significantly increase customer satisfaction by personalizing, providing fast service and automating tourist services (Miró & García, 2024; Doğana & Niyet, 2024).

1. Personalized services. One of the most important advantages of artificial intelligence is the ability to individualize tourist services. AI systems analyze tourists' interests, previous travel experience and online activity and offer them suitable destinations, hotels and services. This approach increases customer satisfaction and takes service quality to a new level.

2. Chatbots and virtual assistants. Scientific studies have shown that chatbots and virtual assistants play an important role in providing tourist services. They operate 24/7, respond quickly to tourists' questions, simplify the booking and information processes (Zaman, 2025). This reduces service delays and increases efficiency.

3. Automated reservation and service systems. Automated reservation systems based on AI are of great importance in the management of hotel and tourism services. They speed up the booking process, reduce human errors, and allocate resources more efficiently. They also provide predictive analytics to predict demand and optimize services (Lina & Talukder, 2024; Pandey et al., 2025).

Table 1

Ways to improve service quality through artificial intelligence

N	Direction	Description	Impact of service on quality	Scientific source
1	Personalized services	Providing individual recommendations based on tourist data	Customer satisfaction and loyalty increases	Miró & García, 2024
2	Chatbots and virtual assistants	24/7 automatic communication and assistance	Fast service, saves time	Zaman, 2025
3	Automated booking systems	Automating booking and service processes	Errors decrease, efficiency increases	Lina & Talukder, 2024; Pandey et al., 2025

Uzbek scientists are also widely studying the possibilities of introducing artificial intelligence and digital technologies into the tourism sector. In particular, the Tourism 4.0 concept, put forward by Abdurakhmonova, Astanakulov, Goyipnazarov, and Irmatova, emphasizes the possibility of increasing the efficiency of automation and management of tourism services through the use of artificial intelligence, the Internet of Things (IoT), and digital platforms (Abdurakhmonova et al., 2023). According to the authors, the introduction of "smart tourism" systems expands the possibilities of providing tourists with timely information, coordinating services, and effectively using resources.

In addition, systems based on artificial intelligence expand the possibilities of optimal resource man-

agement in tourism enterprises. As noted in the scientific literature, AI technologies effectively allocate human resources, time, and financial resources in hotel, transport, and service infrastructure, which improves the overall quality of service (Lina & Talukder, 2024).

Predictive analytics systems based on AI allow for the prediction of seasonal changes in tourism demand. This allows companies to properly plan staffing, prepare service packages, and reduce unnecessary costs. This ensures stability and continuity in the service process (Pandey et al., 2025).

Dynamic pricing systems are also one of the most effective tools of AI. These systems automatically change prices depending on supply and demand, seasonality, and market conditions. As a result, not only do tourism companies increase their profits, but they also create competitive offers for customers (Sharma, 2024).

Scientific studies have shown that resource management through AI technologies not only increases economic efficiency, but also improves the quality of service. Because properly planned resources allow for fast and uninterrupted service delivery to tourists (Ma et al., 2025).

In addition, the issues of integrating artificial intelligence technologies with tourism infrastructure are also playing an important role in modern research. Studies by Astanakulov, Balbaa, Foziljonov, and Batirova emphasize the creation of the opportunity to manage the tourism service system in a single digital environment through the integrated introduction of artificial intelligence and digital technologies (Astanakulov et al., 2024). According to the authors, such integration serves to ensure the consistency of service processes, accelerate data exchange, and increase the efficiency of services. In foreign literature, AI-based forecasting and automation systems are seen as the main factor ensuring absolute efficiency in the tourism sector, but in our opinion, in the conditions of Uzbekistan, the effectiveness of these systems depends on the level of infrastructure and the integration of digital technologies, and it may be difficult to implement them equally quickly for all enterprises. Therefore, phased implementation is important.

Table 2

The role of SI in operational efficiency

№	Direction	Description	Impact on service	Scientific source
1	Predictive analytics	Forecasting tourist flow in advance	Resources are allocated correctly	Pandey et al., 2025
2	Dynamic pricing	Automatic price change based on supply and demand	Revenue increases, competition intensifies	Sharma, 2024
3	Resource management	Optimal allocation of personnel, time and services	Efficiency and service quality increase	Lina & Talukder, 2024
4	Automated systems	AI-based decision-making systems	Errors are reduced, speed increases	Ma et al., 2025

Artificial intelligence (AI) is one of the most important areas of improving the quality of service in the tourism sector, creating the opportunity to collect, analyze and make decisions based on customer feedback. In the modern digital environment, tourists constantly leave feedback about their experiences on Internet platforms, social networks, online booking systems and rating sites. Since it is difficult to analyze this large volume of "Big Data" using traditional methods, AI-based sentiment analysis technologies are gaining importance.

Uzbek researchers are also studying the possibilities of introducing artificial intelligence and digital technologies into the tourism infrastructure. In particular, the Tourism 4.0 concept developed by Abdurakhmonova, Astanakulov, Goyipnazarov and Irmatova substantiates the possibility of automating tourist services and effectively managing resources through the use of intelligent technologies (Abdurakhmonova et al., 2023). According to the authors, "smart tourism" systems are important in increasing the speed and efficiency of service provision.

Sentiment analysis categorizes tourists' opinions into positive, negative, or neutral categories. This allows tourism businesses to assess service quality in real time and quickly identify shortcomings. For example, if there are many negative opinions about a hotel's service, the system automatically alerts management and takes steps to address the problem (Sankar & David, 2023).

Artificial intelligence processes customer opinions in several stages:

1. Data collection (reviews, comments, ratings)
2. Natural language processing (NLP)
3. Sentiment classification
4. Visual analysis of results
5. Management decisions.

Through this process, tourism organizations not only identify problems, but also have the opportunity to predict them in the future (Doğana & Niyet, 2024).

Table 3

Stages of customer opinion analysis through SI

№	Stages	Description	Result
1	Data collection	Obtaining comments from online platforms	A large database is formed
2	NLP analysis	Natural language processing Computer understanding	The meaning of the text is determines
3	Sentiment analysis	Positive/negative/neutral separation	Opinions are classified
4	Visualization	Preparing graphs and reports	Insightful analytics
5	Decision making	Developing a management strategy	Improving service quality

AI-based analytics systems do not just provide statistical information to tourism organizations, but also help them make strategic decisions. For example, it is possible to identify which services are criticized the most, which employees or branches have received high ratings. This allows for the correct allocation of resources and improvement of service standards (Ma et al., 2025).

AI also allows you to anticipate the needs of tourists. For example, if many tourists complain about transport delays or booking problems, the system can systematically analyze this problem and develop proposals to prevent such situations in the future. This ensures a sustainable increase in service quality.

Table 4

Impact of improving service quality through SI

Direction	SI task	Impact on Service
Customer sentiment analysis	Sentiment analysis	Problems are identified quickly
Service monitoring	Real-time data tracking	Quick decision making
Quality control	Feedback evaluation	Service standard increases
Forecasting	Trend prediction	Problems are eliminated in advance

Foreign studies have evaluated AI-based sentiment analysis as the most effective method for automatically monitoring service quality in tourism (Sankar & David, 2023). According to them, AI allows for high-precision decision-making even without human intervention.

However, in our opinion, the fully automated application of this technology in the conditions of Uzbekistan is still at an early stage, since the language, cultural context, and style of expression of local customers' opinions can pose difficulties for AI algorithms. Therefore, a hybrid model that combines human analysis with AI analysis is more effective.

Artificial intelligence is currently radically changing the tourism industry and becoming one of the most important innovative factors in improving service quality. Its main advantages are manifested in the ability to provide personalized services to customers, introduce fast and automated communication systems, and create the opportunity to effectively manage resources. Through AI technologies, tourism companies are able to better understand customer needs, provide them with tailored offers, and optimize service processes.

Analysis shows that AI solutions such as chatbots, virtual assistants, automated booking systems, and dynamic pricing have a significant impact on the speed and quality of service provision in tourism. At the same time, through predictive analytics and resource management, enterprises are achieving economic efficiency by predicting demand and supply. Sentiment analysis serves as an important tool for continuously improving service quality.

However, scientific research and practice also show that there are a number of problems associated with the introduction of artificial intelligence. These include high costs, data security, ethical issues, and limitations associated with personnel training. Therefore, a phased and strategic approach is required when introducing AI technologies into the tourism industry.

Table 5

The relationship between the growth of the Uzbek tourism market and the need to introduce artificial intelligence technologies

№	Tourism market trends (Uzbekistan)	2025 indicators	Challenges for tourism enterprises	Artificial intelligence solutions
1	Increase in the number of foreign tourists	11.7 million people	Increase in customer flow	Introduction of chatbots and virtual assistants
2	Tourist growth rate	+46,8 %	The need to increase the speed of service	Automated booking systems
3	High share of neighboring countries	80 %+	The need for multilingual services	NLP and automatic translation systems
4	Expansion of tourism infrastructure	Increase in the number of new services	Correct resource management	Predictive analytics
5	Intensification of competition in the tourism market	Entry of new operators	Revenue optimization	Dynamic pricing systems

The growth trends observed in the Uzbekistan tourism market require the reorganization of service processes based on modern technologies. In the context of increasing tourist flows and expanding demand for services, automation of services through artificial intelligence technologies, ensuring prompt communication with customers, and effective resource management are gaining importance. This situation indicates the need to accelerate digital transformation processes in the Uzbek tourism market.

At the same time, local scientists are also studying the application of artificial intelligence-based analytical technologies in marketing and data processing processes. Astanakulov, Balbaa, Foziljonov, and Batirova noted that analyzing large amounts of data using intelligent algorithms and digitizing tourism service management processes can increase service efficiency (Astanakulov et al., 2024).

From the point of view of scientific polemics, while in foreign literature AI is considered the main factor that automatically brings tourism services to a higher level, in local conditions, including in Uzbekistan, its effectiveness is directly dependent on the level of infrastructure, digital literacy and practical integration.

At the same time, artificial intelligence is a technology of strategic importance in improving the quality of services, improving customer experience and strengthening competitiveness in the tourism sector, which will serve the further sustainable and innovative development of this sector in the future.

The results of this study show that artificial intelligence is one of the most important innovative factors in improving the quality of services, improving customer experience and ensuring operational efficiency in the tourism sector. The possibilities of personalization, automation of services, predictive analysis and analysis of customer opinions through AI technologies are taking the activities of tourism enterprises to a new level.

The analysis also shows that chatbots, virtual assistants, dynamic pricing and automated booking systems significantly increase the speed and quality of service. At the same time, systems based on artificial intelligence allow for effective resource management and optimization of decision-making processes.

However, it was found that the effectiveness of these technologies is directly related to the level of their implementation, infrastructure capabilities and personnel training. Therefore, the gradual and systematic implementation of artificial intelligence in the tourism sector is of great importance.

In general, the above considerations indicate that the effective implementation of artificial intelligence technologies in the tourism sector requires an integrated approach. That is, the implementation of technologies should be carried out in harmony not only with technical capabilities, but also with human capital, infrastructure and management mechanisms. From this point of view, it is advisable to put forward the following practical proposals:

1. It is advisable to implement the introduction of artificial intelligence technologies in tourism enterprises in a phased manner, starting with chatbots and automated systems.

2. It is necessary to introduce special training programs to improve the digital literacy of employees and use AI technologies.

3. It is necessary to expand the possibilities for more accurate study of customer needs through the widespread implementation of big data and sentiment analysis systems in the Uzbek tourism market.

4. It is important to develop smart tourism infrastructure and integrate digital platforms in cooperation with the public and private sectors.

5. When introducing artificial intelligence systems, strict adherence to data security and ethical standards is required.

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INCREASING THE EFFICIENCY OF THE INFORMATION SYSTEM IN UZBEKISTAN'S TOURISM ACTIVITIES THROUGH PIMS ANALYSIS

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Abstract

This study investigates the possibilities of increasing the efficiency of information systems in Uzbekistan's tourism sector through the application of PIMS analysis. In the context of globalization and rapid digital transformation, tourism is increasingly evolving into a data-driven industry where the quality, integration, and analytical capacity of information systems determine overall performance and competitiveness. The research employs a systematic analytical approach to examine global and national trends, identify key factors influencing the efficiency of tourism information systems, and evaluate existing challenges in Uzbekistan.

The findings indicate that Uzbekistan has achieved significant progress in tourism development, including rapid growth in tourist arrivals, expansion of tourism infrastructure, and the implementation of digital tools such as e-visa systems and unified tourism platforms. These developments have positively contributed to improving accessibility, service delivery, and market expansion. However, the study also reveals critical constraints, including fragmented information systems, limited analytical capabilities, uneven digital infrastructure, and insufficient coordination among stakeholders.

The application of PIMS analysis demonstrates that while external growth factors strongly support the sector, internal system limitations reduce the efficiency of information utilization and decision-making processes. The study concludes that improving the efficiency of tourism information systems requires a comprehensive strategy focused on system integration, advanced data analytics, digital infrastructure development, human capital enhancement, and institutional coordination. The research contributes to the theoretical understanding of tourism digitalization and provides practical recommendations for strengthening the economic efficiency and global competitiveness of Uzbekistan's tourism sector.

Keywords: Tourism information systems, PIMS analysis, economic efficiency, digital transformation, smart tourism, data analytics, tourism competitiveness, system integration, Uzbekistan tourism, information management.

In the context of rapid digital transformation and globalization, the role of information systems in enhancing the efficiency and competitiveness of tourism activities has become increasingly critical. Modern tourism is no longer driven solely by physical infrastructure and natural or cultural resources; instead, it is strongly dependent on the availability, accessibility, and quality of information. In this regard, advanced information systems enable real-time data exchange, improve decision-making processes, enhance service quality, and facilitate the integration of various stakeholders within the tourism ecosystem.

Uzbekistan, as an emerging tourism destination with significant cultural, historical, and pilgrimage tourism potential, has made substantial progress in recent years in developing its tourism infrastructure and digital environment. The country's strategic focus on digitalization, including the introduction of e-visa systems, online booking platforms, and integrated tourism services, reflects its commitment to aligning with global tourism trends. However, despite these advancements, challenges remain in ensuring the efficiency, coordination, and effectiveness of tourism-related information systems. Issues such as fragmented data flows, limited interoperability between platforms, недостаточная analytical capabilities, and the absence of a unified performance evaluation framework continue to constrain the sector's full potential.

In this context, the application of PIMS analysis provides a valuable methodological approach for evaluating and improving the performance of information systems in tourism. Originally developed to analyze the relationship between market strategies and profitability, the PIMS framework can be adapted to assess how different components of tourism information systems such as market share, service quality, technological capacity, and customer satisfaction affect overall efficiency and economic outcomes. By focusing on data-driven performance indicators, PIMS analysis enables a systematic examination of both internal system capabilities and external market conditions.

Furthermore, the increasing complexity of tourism demand, characterized by personalized services, digital interactions, and global competition, necessitates the development of integrated and intelligent information systems. The effectiveness of these systems directly influences tourist satisfaction, operational efficiency, and the overall competitiveness of the national tourism industry. In Uzbekistan, where tourism is recognized as a key sector for economic diversification and sustainable development, improving the efficiency of information systems is particularly important for maximizing economic returns and enhancing the country's position in the global tourism market.

The growing importance of information systems in tourism has attracted significant scholarly attention, particularly in the context of digital transformation and global competitiveness. A substantial body of literature

emphasizes that the efficiency of tourism activities increasingly depends on the quality, integration, and strategic management of information systems. In this regard, several researchers have explored the relationship between information technologies, market performance, and strategic decision-making in tourism.

One of the foundational theoretical frameworks relevant to this study is the PIMS analysis, developed by Buzzell and Gale (1987). Their seminal work demonstrated a strong empirical relationship between market strategy variables such as market share, product quality, and investment intensity and business profitability. Although initially applied in industrial and manufacturing contexts, subsequent studies have adapted the PIMS framework to service industries, including tourism, showing that strategic use of information and data significantly improves organizational performance and efficiency.

In the field of tourism information systems, Buhalis Dimitrios and Law Rob (2008) provided a comprehensive analysis of the role of information and communication technologies (ICT) in transforming the tourism industry. Their research highlights that digital platforms, online distribution systems, and integrated databases enhance operational efficiency, reduce transaction costs, and improve customer satisfaction. The authors concluded that destinations with advanced information systems achieve higher levels of competitiveness and market responsiveness.

Further contributions are made by Sigala Marianna (2018), who examined the impact of big data and analytics on tourism management. Her study emphasizes that data-driven decision-making significantly increases efficiency by enabling real-time monitoring of tourist behavior, demand forecasting, and personalized service delivery. The findings suggest that the integration of advanced analytics into tourism information systems is a key determinant of performance improvement in the digital era.

In addition, Xiang Zheng and Fesenmaier Daniel R. (2017) investigated the influence of digital information sources on tourist decision-making processes. Their research demonstrates that online information systems, including search engines and social media platforms, play a critical role in shaping tourist behavior and destination choice. The study concludes that effective management of digital information flows enhances both marketing efficiency and overall tourism system performance.

From a strategic management perspective, Porter Michael E. (2001) analyzed the role of information technology in competitive advantage. His work argues that IT-based systems, when aligned with business strategy, can create sustainable competitive advantages by improving efficiency, differentiation, and innovation. This perspective is particularly relevant for tourism, where information systems serve as a backbone for coordination between multiple stakeholders.

In the context of developing countries, UN Tourism (2022) reports underline the importance of digital transformation in improving tourism sector performance. The reports indicate that countries investing in integrated tourism information systems such as digital platforms, e-governance tools, and smart tourism solutions achieve higher efficiency, better resource allocation, and increased international competitiveness.

The reviewed literature demonstrates that the efficiency of tourism activities is closely linked to the development and strategic management of information systems. While existing studies provide strong evidence on the benefits of ICT, big data, and digital platforms, there remains a research gap in applying structured strategic frameworks such as PIMS analysis to evaluate and optimize tourism information systems, particularly in the context of emerging economies like Uzbekistan. This study aims to address this gap by integrating strategic analysis with digital tourism development.

In recent years, the world tourism industry has undergone profound positive transformations driven by digitalization, platformization, artificial intelligence, and integrated information management systems. In the context of increasing the efficiency of tourism information systems through PIMS analysis, these changes are especially significant because they directly influence key performance variables such as service quality, market responsiveness, and operational efficiency. Modern tourism increasingly treats information as a strategic economic resource rather than merely a supporting tool. According to UN Tourism, digital transformation is essential for enhancing competitiveness, innovation, and sustainable growth in tourism, highlighting the central role of information systems in the sector (UN Tourism, 2024).

The scale of global tourism recovery and growth further confirms this trend. UN Tourism reports that international tourist arrivals reached approximately 1.4 billion in 2024, representing an 11% increase compared to 2023 and nearly a full recovery to pre-pandemic levels (UN Tourism, 2025). This positive trend continued in 2025, with global tourist arrivals increasing to around 1.5 billion, reflecting sustained demand and expanding global mobility (UN Tourism, 2026). Such large-scale growth has significantly increased the importance of efficient information systems, as managing tourist flows, ensuring service quality, and optimizing resource allocation now require real-time data processing and integrated digital platforms.

From an economic perspective, the global tourism sector has also demonstrated substantial positive changes. According to the World Travel & Tourism Council, in 2025 the sector contributed approximately USD 11.6 trillion to global GDP, accounting for 9.8% of the world economy, while supporting 366 million jobs worldwide (WTTC, 2026). These figures indicate that tourism is not only expanding but also becoming more economically significant. In this context, efficient information systems play a crucial role in maximizing economic returns by improving coordination between stakeholders, enhancing customer experience, and enabling data-driven decision-making.

Another important positive global trend is the rapid integration of artificial intelligence and digital learning systems into tourism management. UN Tourism highlights that the sector is increasingly adopting AI technologies for improving customer service, de-

mand forecasting, and operational efficiency. For example, its digital initiatives include the development of online training platforms, innovation ecosystems, and AI-based tourism solutions, which contribute to the modernization of tourism governance and service delivery (UN Tourism, 2024). This demonstrates that tourism information systems are evolving from passive data storage tools into intelligent systems capable of predictive and strategic functions.

In parallel with global developments, Uzbekistan has also experienced significant positive changes in its tourism sector, particularly in terms of growth and digitalization. According to the National Statistics Committee, in 2024 the number of foreign citizens visiting Uzbekistan for tourism purposes reached 7.957 million, which represents a 20.1% increase compared to 2023 (National Statistics Committee, 2025). This growth continued in 2025, when approximately 11.7 million foreign tourists visited the country, reflecting an increase of 46.8% compared to the previous year (National Statistics Committee, 2026). These figures clearly indicate a rapid expansion of tourism demand, which in turn increases the need for efficient and integrated information systems to manage tourism activities effectively.

Furthermore, the development of tourism infrastructure in Uzbekistan has shown strong positive dynamics. In 2024, the number of travel companies increased by 25.3%, reaching 743 organizations, while the number of tourists served grew by 70.5% and the number of tours sold increased 2.3 times (National Statistics Committee, 2025a). At the same time, hotel infrastructure expanded significantly, with 2,383 accommodation facilities operating in the country, providing over 79,000 beds. These developments demonstrate not only quantitative growth but also structural improvements in the tourism sector. However, such rapid expansion also increases the complexity of coordination, making efficient information systems essential for maintaining service quality and operational efficiency.

A particularly important positive change in Uzbekistan is the institutionalization of tourism digitalization policies. The Cabinet of Ministers adopted Resolution No. 820 on 7 December 2024, aimed at integrating tourism services into a unified digital platform (Cabinet of Ministers, 2024). This initiative represents a major step toward improving the efficiency of tourism information systems by reducing fragmentation, enhancing data integration, and enabling centralized management of tourism services. From the perspective of PIMS analysis, such integration can significantly improve performance indicators such as market reach, service quality, and customer satisfaction.

Additionally, the introduction and development of the electronic visa (e-visa) system in Uzbekistan has greatly improved accessibility for international tourists. The Digital Government Portal reports that the e-visa system simplifies the application process, reduces processing time, and enables online tracking and electronic issuance of visas (Digital Government, 2025). This not only enhances the tourist experience but also generates valuable data for analysis and strategic planning, thereby increasing the efficiency of the tourism information system.

Overall, both global and national trends demonstrate that tourism is increasingly becoming a data-driven and technology-intensive sector. The positive changes observed such as rapid recovery of tourist flows, expansion of tourism infrastructure, and widespread digitalization highlight the growing importance of efficient information systems. In this context, applying PIMS analysis provides a valuable framework for understanding how strategic investments in information systems can improve the economic efficiency and competitiveness of tourism activities, particularly in emerging destinations like Uzbekistan.

Evaluating the efficiency of tourism information systems requires not only descriptive analysis but also strategic performance assessment tools. One of the most suitable approaches in this regard is the PIMS analysis, which examines how key strategic variables influence performance outcomes. Although originally developed for industrial sectors, the PIMS framework has been widely adapted to service industries, including tourism, where factors such as market share, service quality, technological capacity, and customer satisfaction directly affect efficiency and profitability.

From a scientific perspective, applying PIMS analysis to tourism information systems allows us to link input factors (strategic variables) with output indicators (performance results). In Uzbekistan's tourism sector, the rapid growth in tourist arrivals, expansion of tourism enterprises, and ongoing digital transformation initiatives create a favorable environment for such analysis. At the same time, challenges related to system integration, data fragmentation, and limited analytical capabilities highlight the need for a structured evaluation framework.

In this study, the efficiency of tourism information systems is assessed based on key PIMS variables, including digital infrastructure level, system integration, data accessibility, service quality, and user satisfaction. These variables are analyzed in relation to performance indicators such as tourist flow growth, revenue potential, operational efficiency, and international competitiveness.

Table 1

PIMS Analysis Table for Tourism Information System Efficiency (Uzbekistan)

PIMS Strategic Variables	Current State in Uzbekistan	Impact on Efficiency	Performance Outcome
Market share (tourist inflow growth)	Rapid growth (11.7 mln tourists in 2025)	High positive impact	Increased tourism revenues and global visibility
Service quality (digital services)	Improving (e-visa, online services)	Moderate–high impact	Higher tourist satisfaction and repeat visits
Technological capacity (IT infrastructure)	Developing but uneven	Medium impact	Partial efficiency gains, but system fragmentation remains
System integration (platform connectivity)	Limited integration	High negative constraint	Reduced coordination and efficiency losses
Data accessibility & analytics	Limited analytical capability	High constraint	Weak decision-making and forecasting accuracy
Customer orientation (user experience)	Growing focus	Positive impact	Improved competitiveness and service perception
Government support & policy	Strong (Resolution No. 820, digitalization)	High positive impact	Accelerated digital transformation
Innovation level (AI, smart tourism)	Emerging stage	Medium potential	Future efficiency growth potential

The PIMS analysis reveals that Uzbekistan's tourism information system demonstrates strong growth-driven performance, primarily supported by increasing tourist inflows and active government policies promoting digitalization. These factors positively influence overall economic efficiency by expanding market size and improving service accessibility.

However, the analysis also identifies several structural constraints that limit the full realization of efficiency gains. In particular, limited system integration and insufficient analytical capabilities emerge as critical weaknesses. From a PIMS perspective, these variables have a disproportionately high impact because they directly affect the ability to convert market growth into sustainable performance outcomes. In other words, while demand-side indicators are strong, supply-side information systems are not yet fully optimized.

Furthermore, technological capacity and innovation levels are still in a transitional stage. Although initiatives such as e-visa systems and unified tourism platforms indicate progress, the lack of advanced data analytics, real-time monitoring systems, and AI-based decision tools reduces overall system efficiency. This suggests that the marginal return on investment in digital infrastructure could be significantly increased if accompanied by stronger integration and analytical capabilities.

At the same time, the analysis highlights substantial future opportunities. The combination of strong government support, growing tourism demand, and ongoing digital reforms creates favorable conditions for improving information system efficiency. If Uzbekistan successfully enhances system integration, expands data analytics capabilities, and adopts smart tourism technologies, it can significantly improve both operational efficiency and international competitiveness.

Overall, the application of PIMS analysis demonstrates that the efficiency of tourism information systems in Uzbekistan is positively influenced by external growth factors but constrained by internal system limitations. Therefore, improving efficiency requires a strategic focus on:

– strengthening system integration
– enhancing analytical capabilities
– expanding digital infrastructure
– and adopting advanced technologies such as AI and big data

Such improvements will enable the tourism sector to fully capitalize on its growth potential and achieve higher levels of economic efficiency in the global tourism market.

In the process of digital transformation, Uzbekistan's tourism sector has achieved notable progress; however, several systemic challenges continue to constrain the efficiency of its information systems. These problems are multidimensional and interrelated, affecting both operational performance and the sector's ability to fully capitalize on growing tourist demand. From a scientific and strategic perspective—particularly when viewed through the lens of PIMS analysis—these constraints can be understood as weaknesses in key performance drivers such as technological capacity, data integration, and customer responsiveness, which ultimately reduce overall efficiency and competitiveness.

One of the primary problems is the fragmentation of tourism information systems. Currently, many digital services—such as booking platforms, visa systems, accommodation databases, and transport information—operate in isolation rather than as part of a unified ecosystem. This lack of interoperability leads to duplication of data, inconsistencies in information, and inefficiencies in service delivery. As a result, both tourists and service providers face increased transaction costs and reduced convenience. From a PIMS perspective, this directly weakens system integration, which is a critical determinant of performance efficiency.

Another significant issue is the limited level of analytical capability and data utilization. Although large volumes of tourism-related data are generated through digital platforms, they are not always effectively processed or transformed into actionable insights. The absence of advanced data analytics, real-time monitoring systems, and predictive tools restricts the ability of policymakers and businesses to make informed decisions.

Consequently, demand forecasting, pricing strategies, and marketing campaigns often lack precision, reducing the overall effectiveness of tourism operations.

The uneven development of digital infrastructure across regions also presents a major constraint. While major cities and key tourist destinations have relatively well-developed digital services, rural and peripheral areas often suffer from insufficient internet connectivity, limited access to digital platforms, and lower levels of technological adoption. This creates disparities in service quality and limits the development of regional tourism potential, particularly in areas with high cultural or pilgrimage tourism value.

In addition, there are institutional and human capital challenges. The successful implementation of advanced information systems requires skilled personnel capable of managing digital platforms, analyzing data, and implementing innovative solutions. However, there is still a shortage of highly qualified specialists in areas such as data analytics, IT system management, and digital tourism strategy. This gap reduces the efficiency of system utilization and slows down the adoption of modern technologies.

Another important constraint is the limited level of integration between stakeholders in the tourism ecosystem. Effective tourism information systems require coordination among government agencies, private businesses, educational institutions, and technology providers. In practice, however, collaboration is often insufficient, leading to fragmented decision-making and reduced system efficiency.

Despite these challenges, there are clear and achievable solutions that can significantly enhance the efficiency of tourism information systems in Uzbekistan. First and foremost, it is essential to develop a unified digital tourism platform that integrates all key services, including visa processing, accommodation booking, transport information, and tourist services. Such a platform would reduce fragmentation, improve data consistency, and enhance user experience.

Secondly, there is a need to strengthen data analytics and artificial intelligence capabilities. The introduction of big data technologies, machine learning algorithms, and real-time analytics systems would enable more accurate demand forecasting, personalized service delivery, and efficient resource allocation. This would significantly improve decision-making processes and overall system performance.

Third, investment in digital infrastructure should be expanded, particularly in regional and rural areas. Improving internet connectivity, expanding access to digital services, and supporting the adoption of new technologies will help ensure more balanced tourism development across the country.

Fourth, it is crucial to develop human capital by investing in education and training programs in digital tourism, data analytics, and information system management. Collaboration with universities and international institutions can play a key role in building the necessary skills and competencies.

Fifth, enhancing stakeholder collaboration is essential for improving system efficiency. Establishing public-private partnerships, creating data-sharing mechanisms, and developing coordinated strategies will help align the interests of different actors and improve overall system performance.

Finally, the implementation of advanced evaluation frameworks, such as PIMS-based performance analysis, should be expanded. This will allow for continuous monitoring of system efficiency, identification of bottlenecks, and evidence-based policy adjustments.

In conclusion, while Uzbekistan's tourism information systems face several structural and operational challenges, these issues can be effectively addressed through a combination of technological, institutional, and strategic measures. By focusing on integration, analytics, infrastructure, and human capital, the country can significantly improve the efficiency of its tourism information systems and strengthen its position in the global tourism market.

The study demonstrates that in the era of globalization and digital transformation, the efficiency of tourism activities in Uzbekistan is increasingly determined by the performance of information systems. The analysis confirms that tourism is no longer a purely service-based sector but a data-driven and technology-intensive system, where information flows, digital platforms, and analytical capabilities play a decisive role in shaping competitiveness and economic outcomes. The application of PIMS analysis has proven to be particularly valuable, as it allows for a structured evaluation of how strategic variables such as technological capacity, system integration, service quality, and market growth affect overall efficiency.

The findings reveal that Uzbekistan has achieved significant progress in tourism development, including rapid growth in tourist arrivals, expansion of tourism infrastructure, and the implementation of digital initiatives such as e-visa systems and unified platform strategies. These factors positively influence the efficiency of the tourism sector by increasing accessibility, improving service delivery, and enhancing the country's global visibility. However, the research also identifies critical challenges that limit the full realization of these benefits. In particular, issues related to fragmented information systems, limited analytical capabilities, uneven digital infrastructure, and insufficient stakeholder coordination continue to constrain system efficiency.

From a strategic perspective, the study highlights that the economic efficiency of tourism information systems depends not only on the availability of digital technologies but also on their integration, intelligent use, and alignment with market strategies. In other words, technological investments alone are not sufficient; they must be complemented by institutional reforms, human capital development, and data-driven governance.

Based on these findings, the following policy recommendations are proposed:

First, it is essential to establish a fully integrated national tourism information system that unifies all key services such as visa processing, accommodation, transport, and tourism products into a single digital platform. This will reduce system fragmentation, improve coordination, and enhance overall efficiency.

Second, Uzbekistan should prioritize the development of advanced data analytics and artificial intelligence capabilities. The introduction of big data platforms, predictive analytics, and real-time monitoring systems will enable more accurate demand forecasting, personalized services, and evidence-based decision-making.

Third, investment in digital infrastructure should be expanded, particularly in regional and rural areas. Ensuring equal access to digital services will not only improve system efficiency but also promote balanced regional tourism development.

Fourth, there is a need to strengthen human capital in digital tourism management by introducing specialized training programs, academic curricula, and international collaborations focused on data analytics, IT systems, and smart tourism technologies.

Fifth, enhancing institutional coordination and stakeholder collaboration is crucial. Developing public-private partnerships, creating unified data-sharing frameworks, and aligning strategic objectives across institutions will significantly improve system performance.

Finally, it is recommended to implement continuous performance evaluation using PIMS-based analytical frameworks. This will allow policymakers and industry stakeholders to monitor efficiency levels, identify bottlenecks, and adjust strategies in a timely and effective manner.

In conclusion, increasing the efficiency of tourism information systems in Uzbekistan requires a comprehensive and integrated approach that combines technological innovation, strategic management, and institutional development. By addressing existing challenges and leveraging digital transformation opportunities, Uzbekistan can significantly enhance the competitiveness and economic efficiency of its tourism sector, positioning itself as a modern and intelligent tourism destination in the global market.

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MEDICAL SCIENCES

EFFICACY OF CURRENT DRUGS AGAINST SOIL-TRANSMITTED HELMINTHS

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Abstract

Soil-transmitted helminth (STH) infections are among the most widespread parasitic diseases worldwide, with children being particularly at risk. Drugs belonging to the benzimidazole group, such as albendazole and mebendazole, are widely used in preventive chemotherapy and play a significant role in reducing morbidity. However, in recent years, resistance to these drugs has emerged as a concern.

Fecal egg count reduction tests (FECRT) and mutations in the β-tubulin gene (F200Y, F167Y, E198A) are used as primary indicators. Results show that albendazole and mebendazole maintain high efficacy against *Ascaris lumbricoides*, but their effectiveness against *Trichuris trichiura* and Hookworm infections has decreased in some regions.

Combination therapies (albendazole + ivermectin/oxantel pamoate) demonstrate higher efficacy than monotherapy, with egg reduction rates of 82–95%. Monitoring of antihelminthic drugs and implementing combination treatment strategies are essential to prevent resistance and achieve the 2030 targets for the elimination of geohelminth infections.

Xülasə

Geohelmintozlar dünyada geniş yayılmış parazitar xəstəliklərdəndir, xüsusilə uşaqlar ən çox risk altındadır. Albendazol və mebendazol kimi benzimidazol qrupuna aid dərmanlar profilaktik kimyaterapiyada geniş istifadə olunur və xəstələnmənin azalmasında əhəmiyyətli rol oynayır. Lakin son illərdə bu dərmanlara qarşı rezistentlik problemləri yaranmışdır.

Fekal yumurta sayının azalması testi (FECRT) və β-tubulin genindəki mutasiyalar (F200Y, F167Y, E198A) əsas göstəricilər kimi istifadə olunur. Nəticələr göstərir ki, albendazol və mebendazol *Ascaris lumbricoides*-a qarşı yüksək effektivliyini saxlayır, lakin *Trichuris trichiura* və Ankilostomidozlarda effektivlik bəzi regionlarda azalmışdır.

Kombinə terapiyalar (albendazol + ivermektin/oxantel pamoat) monoterapiyadan daha yüksək effektivlik göstərir (yumurta sayının azalması 82–95%). Antihelmint preparatların monitorinqi və dərman kombinasiya strategiyalarının tətbiqi rezistentliyin qarşısını almaq və 2030-cu il üçün geohelmintozların eliminasiyası hədəflərinə nail olmaq üçün vacibdir.

Keywords: soil-transmitted helminths, albendazole, mebendazole, ivermectin, combination therapy, anthelmintic resistance

Açar sözlər: geohelmintoz, albendazol, mebendazol, ivermektin, kombinə terapiya, antihelmint rezistentlik

Giriş: Torpaqla keçən helmintozlar (geohelmintozlar) insanlarda ən çox yayılmış parazitar xəstəliklərdəndir. Ümumi Səhiyyə Təşkilatı (ÜST) məlumatlarına görə bütün dünyada təqribən 2 milyard insan, o cümlədən ÜST Avropa Regionu üzrə 4 milyon uşaq geohelmintozlardan əziyyət çəkir (1). Son illərdə bu helmintlərlə mübarizədə kimyaterapiyanın rolu xeyli artmış və kütləvi kimyaterapiya yolu ilə xəstələnmənin azaldılması üçün real imkan yaranmışdır.

Geohelmintozların müalicəsində yüksək keyfiyyətli antiparazitar preparatların geniş tətbiqinə və müəyyən uğurlu nəticələr əldə edilməsinə baxmayaraq bu sahədə bir sıra problemlər qalmaqdadır (2).Belə ki, geohelmintozların müalicəsində işlədilən antihelmint preparatlara davamlılığın əmələ gəlməsi müalicəsinin effektivliyini azaldır və rasional mübarizə tədbirlərinin keyfiyyətli aparılmasına mane olur (3). 2030-cu ilə qədər uşaqlarda geohelmintozların eliminasiyasına nail olmaq Ümümdünya Səhiyyə Təşkilatlarının (ÜST) global hədəflərindən biridir (4).

Məktəbəqədər və məktəb yaşlı uşaqlar arasında aparılan dehelmintizasiyanın nəticələrinin sistematik təhlilində meta analizlərdə istifadə edilmişdi (5). Profilaktik kimiyaterapiyanın aparmasında əsas məqsəd xəstələrin sayının azadılmasıdır (6). ÜST bu məqsədlə əsasən albendozol (400 mq) və mebendazol (500 mq) bir dəfəlik dozalarını tövsiyə etmişdir.Geohelmintoz invaziyalarına nəzarət etmək üçün ÜST 2017 -cı ildə profilaktik kimyaterapiya təlimatını nəzərdən kecirmiş və bu barədə tövsiyələr verilmişdir.Eyni zamanda antihelmint preparatların effektivliyinin monitorinqinin aparılması və bu preparatlara davamlıq risklərinin azadılması məqsədilə antihelmint dərman kombinasiyalarından istifadə tövsiyə edilmişdir (7).

Albendazol və mebendazol həm tək həm də digər antihelmint preparatlarla birlikdə (kombinasiyada) bütün dünyada 30 ildən artıqdır ki, geniş şəkildə istifadə olunur .Albendazolun geohelmintozlara qarşı əldə edilən bu effektilik göstəricisi ÜST tərəfindən tövsiyə edilən qənayətbaxış effektivlik kimi təyin edilmişdir (8).

Hazırda dünyada geohelmintlərə qarşı yaranan rezistentlik ciddi problem olaraq qəbul olunur.

Bütün dünyada regionlar üzrə antihelmint preparatlara rezistentlik aşağıdakı kimidir.

Afrikada (Tanzaniya, Keniyada) - Trixosefalyozun (Trichuris trichiura) albendazol ilə müalicədə FECRT (Fecal Egg Count Reduction Test) - Nəcis nümunəsində yumurta sayının azalması testi -40-60%; β tubinin mutasiyasında bəzi ərazilərdə F200Y aşkar edilmişdir.

Cənub-Şərqi Asiyada - Trichocephalus trichiurus FECRT- 50%, β tubilin F200Y müəyyən edilmişdir.

N. Amercanus Afrikada - FECRT - orta - 80% az sayda mutasiya müəyyən edilmişdir. Cənubi Asiyada (Hindistan, Nepal) FECRT- 50-60% - F200Y; Trichocephalus trichiurus müəyyən edilmişdir.

Ascaris lumbricoides - FECRT>95% mutasiya müşahidə olunmamışdır. Latın Amerikasında (Kolumbiya, Brazilya) - Trichocephalus trichiurus 50-60%, F200Y mutasiyası rast gəlinmişdir, Ancylostoma duodenale- FECRT - 78-85% - mutasiya məlumat yoxdur.

Avropa/MDB.- Ascaris lumbricoides - albendazol ilə müalicədə birdəfəlik dozada FECRT> 90-95% olmuşdur, mutasiyalar aşkarlanmamışdır.

Afrikada bəzi ərazilərdə Trichocephalus trichiurus qarşı albendazolun effektivliyi aşağı düşüb (mutasiyalar təsdiqlənib). Asiya, Hindistan, Çin və Cənub Şərqi Asiyada Trichocephalus trichiurus və ancylostoma duodenale populyasiyalarında davamlıq halları qeyd olunub. Latın Amerikası: Kolumbiya, Brazilyada - Trichocephalus trichiurus populyasiyalarında β-tubulin mutasiyalar qeyd olunub.

Xüsusilə benzimidazol qrupuna aid olan preparatlara (albendazol və mebendazol) bu zaman müalicədə dərman kombinasiyalarının istifadəsinə ehtiyac yüksəlir .

Belə ki, aparılmış tədqiqatlarda məlum olmuşdur ki, trisosefalyozda albendazol , ivemektin kombinasiyasında ERR effekti 82% , tək albendazol ilə müalicədə isə bu 30-40% -dır. Albendazol Oxantel Pomatla birgə kombinasiya trixosefalyoza yüksək seçici təsir etməsi aşkar edilmişdir.

Antihelmint preparatlara davamlığın təyin edilməsi geohelmint invaziyalarının müalicəsində effektivliyin azalmasını aşkar etmək və nəzarət tədbirlərini təkmilləşdirmək son dərəcə vacibdir.

Dünya əhalisnin dörddə birindən çoxu geohelmintozlarla yoluxmuşdur. Geohelmintozlar xüsusilə dünyanın tropik və subtropik zonalarında geniş yayılmışdır. Məktəbəqədər, məktəb yaşlı uşaqlar ən həssas təbəqədir (3).

2030-cu ilə qədər uşaqlarda geohelmintozların eliminasiyasına nail olmaq Ümumidünya Səhiyyə Təşkilatının [ÜST] global hədəflərindən biridir .

Kütləvi kimyəvi profilaktika bu hədəfə nail olmaq üçün istifadə edilir. ÜST bildirmişdir ki, geohelmintozların endimik olduğu 103 ölkədə təxminən 267,5 milyon məktəb yaşlı uşağın müalicəyə ehtiyac var (4). 2021-ci ilin məlumatına görə dünyada geohelmintlərə endemik ölkələrdə yoluxma riski altında olan təxminən 500 milyon uşaq profilaktik kimyaterapiya almışdır.

Məktəbəqədər və məktəb yaşlı uşaqlar arasında aparılan dehelmintizasiyaların nəticələrinin sistematik təhlilində meta-analizlərdən istifadə edilmişdir. 2008-ci ildə Klizer Vtzinger, 2017-ci ildə Moser et.al öz tədqiqatlarında meta analizdən istifadə edərək bütün yaş populyasiyalarında geohelmintozlara qarşı müxtəlif antihelint preparatların effektivliyinə dair araşdırmalar aparılmışlar (2,5).

Profilaktik kimyaterapiyanın aparılmasında əsas məqsəd xəstələrin sayının azaldılmasıdır (6). ÜST bu məqsədlə əsasən albendazol (400 mq) və mebendazolun (500 mq) bir dəfəlik dozalarını tövsiyə etmişdir. Geohelmintoz invaziyalarına nəzarət etmək üçün ÜST 2017-ci ildə profilaktik kimyaterapiya təlimatını nəzərdən keçirmiş və bu barədə tövsiyələr vermişdir, eyni zamanda antihelmint preparatların effektivliyinin monitorinqi aparılması bu preparatlara davamlıq risklərinin azaldılması məqsədlə dərman kombinasiyalarından istifadə tövsiyə edilmişdir (7).

Aparılmış tədqiqatlarda – müalicə alan uşaqların cinsi, yaşı, xəstəliyinin klinik vəziyyəti (ağır, yüngül, orta, simptomatik, asimptomatik), müalicə sxemləri, müayinə üçün götürülən nümunənin miqdarı, diaqnostik üsullar (mikroskopik, molekulyar) (qPCR), invaziyanın intensivliyi, müalicədən əvvəl və sonra nəcisin hər qramında yumurtaların sayı [EPG], müalicənin nəticələri və digər müvafiq məlumatlar daxil edilmişdir. Albendazol və mebendazol həm tək həm də digər antihelmint preparatlarla birlikdə (kombinasiyada), bütün dünyada 30 ildən artıqdır ki, geniş şəkildə istifadə olunur .

Albendazol 1982-ci ildən insan geohelmintozlarının müalicəsində tədbiq edilir . Albendazolun geohelmintozlara qarşı əldə edilən bu effektivlik göstəricisi ÜST tərəfindən tövsiyə edilən qənaətbaxış effektivlilik kimi təyin edilmişdir (8). Albendazolun və ya mebendazolun digər antihelmint preparatlarla moksidektin (8-24 mq/kq), ivermektin (200 mq/kq) kombinasiyalarda tədbiqi, albendazolun effektivliyini əhəmiyyətli dərəcədə artırmışdır. Bəzi tədqiqatlarda oxantel pamoatın (20 mq/kq həm dozada) və ya albendazol (400 mq/kq tək dozada) kombinasiyada istifadəsi geohelmintozların müalicəsində alternativ dərman kimi istifadəsi təklif edilmişdir (10). Beləliklə, pirantel pamoat və oxantel pomoaten albendozol və mebendazol ilə birgə kombinasıda istifadəsi geohelmintozların müalicəsində bir seçim ola bilər (11).

Qeyd edilən müalicənin effektivliyinə eyni zamanda invaziyanın intensivliyi, sahib orqanizmin immun statusu təsir edə bilər (12).

Antihelmint preparatlara qarşı davamlılıq yaranması ehtimal olunur və müxtəlif ərazilərdə geniş yayılmışdır. Antihelmint preparatlara qarşı davamlılığın yaranması öz təsdiqini tapması ÜST tərəfindən 2030-cu ildə nəzərdə tutulan məqsədlərə nail olmağa mane ola bilər (9).

Geohelmintozların müalicəsində istifadə edilən spesifik antihelmint preparatlara rezistentlik bütün dünya üzrə qiymətləndirilmişdir (3).

Geohelmintlərin Albendazol, mebendazol (benzimidazolar), levemizol, pyrantel pamoat - bu preparatların rezistentlik effektivliyi tədqiq edilmişdir.

Dərman davamlığının əsas göstəriciləri - antihelmint preparatlara qarşı müalicə effektinin azalması, klinik sağalma və parazitoloji göstəricilərin faizinin azalması - ilə müəyyən edilir.

Eyni zamanda bu məqsədlə molekulyar markerlərdən də istifadə edilir .

Benzimidazol qrupu preparatlara qarşı rezistentlikdə ən çox rast gələn markerlər;

β-tubilin genindəki SNP-lər (nöqtəvi mutasiyalar), F200Y, F167Y, E198A- tipli mutasiyalardır.

Rezistentliyin qiymətləndirmə üsullarına aşağıdakılar aiddir.

Fekalda yumurta sayının azalma tezti (FECRT): Müalicədən əvvəl və sonra helmintin sayı müqayisə edilir. Belə ki,müalicədən əvvəl nəcis nümunələri götürülür və yumurta sayı (epg – eggs per gram) ölçülür. Standard dozada antihelmint preparat tətbiq edilir (məsələn, albendazol 400 mg və ya mebendazol 500 mg) və müalicədən 7–14 gün sonra yenidən nəcis nümunələri götürülür. ÜST tərəfindən dəyərləndirmənin qiymətləndirilməsi aşağıdakı kimi qəbul edilib (ÜST) ≥95% – normal effektivlik, 90–95% – şübhəli, <90% – davamlılıq ehtimalı yüksəkdir

Genetik markerlərin araşdırılması

Davamlılıqla əlaqəli molekulyar mutasiyalar, xüsusilə β-tubulin genindəki dəyişikliklər, qlobal protokollarda əsas marker kimi qəbul edilmişdir, bu müayinələrdə PCR (Polymerase Chain Reaction), qPCR (Quantitative PCR) metodlarından istifadə edilməklə aparılır.

Bu mutasiyalar benzimidazol qrupu dərmanlara (məsələn, albendazol, mebendazol) davamlılıqda aşkar edilir. Bundan başqa, In vitro testlərdən də istifadə edilir. Bu üsullar laborator şəraitdə helmintlərin preparata reaksiyasını birbaşa yoxlayır. Bu zaman Egg hatch assay (EHA) – yumurtalardan sürfənin çıxmasını bloklayan antihelmint preparatın dozası müəyyən edilir, Larval development assay (LDA) – metodunda Larva sürfələrin inkişafının inhibisiyası qiymətləndirilir, Larval motility assay – Larva hərəkətliliyinin azalması müəyyən edilir.

Bu zaman müalicədən əvvəl və sonra yumurta sayının müqayisəsi, molekulyar diaqnostika: PCR ilə β-tubuilin mutasiyasının aşkarlanması, in vivo və in vitro testlər,helmint yumurtalarının izolyasiyası və bu yumurtaların tədqiqi üsullarından istifadə edilir.

Antihelmint preparatlara monitorinqlərin aparılması rezistentliyi qiymətləndirilməsi məqsədi ilə tövsiyyə olunur.

Dərman davamlılığının erkən aşkar edildikdə tək dərmanla müalicə əvəzinə kombinasiyalardan isifadə edilməlidir. (məs, albendazol+ivermektin), Eyni zamanda rezistentliyə şübhə yaranan hallarda dərmanların təkrar istifadəsinin qarşısını almaq lazımdır.

Hazırda dünyada geohelmintlərə qarşı yaranmış antihelmint rezistentlik ciddi problem olaraq qəbul olunur. Xüsusilə benzimidazol qrupuna (albendazol və mebendazol) - bu zaman dərman kombinasiyaları ehtiyac yüksəlir.

1. Albendazol+İvermektin

Trixosefalyozda alben+ivermekt ilə müalicədə 82% qədər yumurta sayının azalması qeyd edilib(tək albendazola müalicədə isə bu 30-40 %- dir)

Albendazolun + Oxantel Pamoatla birgə kombinasiyası T. trich -ya yüksək seçici təsir edir. 2021-ci ildə WHO apardığı təhlildə bu kombinasiya ilə yumurta (ifrazı) 95%-ə qədər azaldığı qeyd edilmişdir. 2021-ci ildə Tanzaniyada və Efiopiyada aparılmış tədqiqatlarda kombinasiyalarda effektlik monoterapiyadan 3-4 dəfə yüksək olmuşdur.

Albendazol+Mebendazol kombinasiyası nadir hallarda istifadə olunur (çünki eyni təsir mexanizminə malikdir). İstifadə müddət artıqca effektlik artır, lakin toksiklik yüksəlir.

Aparılmış tədqiqatlarda məlum olmuşdur ki, albendazol+levamizol - askarid və ankilostomidozlara qarışıq invaziyalarinda daha effektivlidir.

Bu kombinasiyada yumurta sayının >90 azalması və təkrar yoluxma riski azalması qeyd edilmişdir.

Antihelmint preparatlara davamlılığın təyin edilməsi,geohelmint invaziyalarının müalicəsində effektivliyin azalmasını aşkar etmək və nəzarət tədbirlərini təkmilləşdirmək baxımından son dərəcə vacibdir. Davamlılığın müəyyən olunması üçün beynəlxalq səviyyədə istifadə olunan protokol mövcuddur.

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LEMIERRE SYNDROME COMPLICATED BY CERVICOFACIAL NECROTIZING INFECTION – CASE REPORT

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Abstract

Background: Lemierre syndrome is a rare but potentially fatal condition characterized by septic thrombophlebitis of the internal jugular vein, most commonly following an oropharyngeal infection caused by Fusobacterium necrophorum.

Case presentation: We report the case of a 34-year-old previously healthy patient who presented with severe sepsis following an untreated pharyngitis. The clinical course was complicated by cervicofacial necrotizing fasciitis, internal jugular vein thrombosis, and septic pulmonary emboli.

Management and outcome: The patient required emergency surgical intervention with extensive debridement and drainage, broad-spectrum antibiotic therapy, anticoagulation, and intensive supportive care.

Conclusions: Early recognition, aggressive surgical management, and multidisciplinary care are essential to improve outcomes in severe forms of Lemierre syndrome.

Keywords: Lemierre syndrome; Fusobacterium necrophorum; sepsis

1. Introduction

Lemierre syndrome, first described by André Lemierre in 1936, is a rare but severe complication of oropharyngeal infections [1]. It is characterized by septic thrombophlebitis of the internal jugular vein and metastatic septic emboli, most commonly affecting the lungs [2,3].

Although historically considered a "forgotten disease" due to widespread antibiotic use, its incidence appears to be increasing in recent years [4].

2. Case Report

A 34-year-old male patient with no significant past medical history presented to the emergency department with: high fever (39.5°C), severe odynophagia, left temporomandibular, swelling with fistulization, altered general condition (fig. 1-2)

Fig. 1-2

Symptoms had begun approximately 7 days prior and were initially treated symptomatically at home, without antibiotics.

Clinical examination: toxic appearance, tachycardia: 110 bpm, hypotension: 100/60 mmHg, left cervical pain with extension along thesternocleidomastoid muscle, hyperemic pharynx without visible purulent exudate.

Laboratory findings leukocytosis: 23,500/mm³ with neutrophilia, elevated CRP and procalcitonin, electrolyte imbalance (hyponatremia, hyperkalemia, hypocalcemia,

hypomagnesemia), metabolic acidosis with increased anion gap.

Blood cultures identified Fusobacterium necrophorum.

Contrast-enhanced cervico-thoracic CT revealed thrombosis of the right internal jugular vein and multiple peripheral pulmonary nodules suggestive of septic emboli.

he diagnosis of Lemierre syndrome was established based on:

- recent oropharyngeal infection
- identification of anaerobic pathogen
- internal jugular vein thrombosis
- septic pulmonary emboli

Surgical treatment

Emergency surgery was performed under local anesthesia, due to the severity and extent of infection. The following procedures were undertaken:

- excision of fistulous tract (fig. 3-4)
- incision and drainage of purulent collections
- opening of involved fascial spaces: pterygomandibular, submandibular, genian (supra- and sub-buccinator), infratemporal
- extensive excisional debridement to viable tissue (fig. 5)
- extraction of tooth 2.8 (without oroantral communication)

Fig. 3-4

Fig. 5

Medical treatment: broad-spectrum antibiotics (carbapenem-based regimen – Imipenem or equivalent)

- anti-inflammatory and analgesic therapy
- hydroelectrolytic and acid-base correction
- cardiovascular support
- oxygen therapy
- gastric protection
- vitamin supplementation (B-complex and C-vitamin)
- mucolytics (N-acetylcysteine)
- anticoagulation (Enoxaparin 0.4–0.6 mL once or twice daily)

Local care

- repeated intraoperative lavage (hydrogen peroxide, saline, antiseptics)
- drainage tubes
- daily postoperative irrigation with povidone-iodine.

The patient's evolution was favorable, with discharge in the course of local healing two weeks postoperatively (fig. 6-7)

Fig. 6-7

3. Discussion

Lemierre syndrome is most commonly caused by Fusobacterium necrophorum, an anaerobic Gram-negative bacillus that colonizes the oropharynx [2,5].

The pathophysiology involves:

primary oropharyngeal infection, invasion of the lateral pharyngeal space,

septic thrombophlebitis of the internal jugular vein, hematogenous dissemination with septic emboli [3,7].

Severe complications, including necrotizing soft tissue infections and even gas-forming infections, although rare, have been reported in the literature [8].

Early recognition is essential, as delayed diagnosis is associated with increased morbidity and mortality [4,7].

This case illustrates a severe and atypical presentation of Lemierre syndrome, complicated by cervicofacial necrotizing fasciitis and features suggestive of gas-forming infection.

Such complications are rare but may occur due to: septic thrombosis, tissue ischemia, rapid spread of anaerobic infection.

The disease progression is often fulminant, with potential complications including: mediastinitis, cavernous sinus thrombosis, pulmonary abscesses, cerebral abscesses.

Management requires a multidisciplinary approach involving:

- oral and maxillofacial surgery
- otorhinolaryngology
- intensive care
- general surgery

Management of Lemierre syndrome also requires early administration of broad-spectrum antibiotics with anaerobic coverage, most commonly targeting Fusobacterium necrophorum [2,5].

The role of anticoagulation remains controversial but may be considered in selected cases with extensive thrombosis [6].

A notable aspect of this case is the extensive surgical intervention performed under local anesthesia in a resource-limited setting, while still adhering to key surgical principles:

wide drainage, aggressive debridement,

effective control of the septic focus.

4. Conclusions

Lemierre syndrome associated with cervicofacial necrotizing infection represents a life-threatening condition requiring immediate intervention.

Early diagnosis, prompt initiation of appropriate antibiotic therapy, and aggressive surgical management are critical for patient survival.

This case emphasizes the importance of rapid septic focus control and coordinated multidisciplinary care in managing severe infections of oropharyngeal origin.

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UNIVERSAL PROGNOSTIC ROLE OF LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN EUROSCORE II, STS, AND MAGGIC MODELS

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Abstract

Objective. To evaluate the universal prognostic value of left ventricular diastolic dysfunction (LVDD) when added to various clinical risk scores (EuroSCORE II, STS, MAGGIC) in patients undergoing coronary artery bypass grafting (CABG).

Materials and Methods. The study included 178 patients with coronary artery disease who underwent elective CABG. Clinical, echocardiographic, and functional parameters were analyzed, including the assessment of left ventricular diastolic function. EuroSCORE II, STS, and MAGGIC risk scores were calculated for all patients. The prognostic value of the models was assessed using ROC analysis (AUC), DeLong test, risk reclassification indices (NRI, IDI), and Decision Curve Analysis.

Results. Left ventricular diastolic dysfunction was an independent predictor of postoperative complications. The addition of LVDD to the EuroSCORE II, STS, and MAGGIC models significantly improved their discriminative ability (ΔAUC = 0.07–0.08; $p < 0.05$ for all models). NRI and IDI indices demonstrated a statistically significant improvement in risk stratification across all models. Decision Curve Analysis showed increased clinical usefulness of the combined models across a wide range of risk thresholds.

Conclusion. LVDD is a universal functional risk modifier that improves the prognostic accuracy of various clinical models. Inclusion of left ventricular diastolic function assessment in preoperative risk stratification algorithms for CABG may significantly improve clinical decision-making.

Keywords: CABG, diastolic dysfunction, EuroSCORE II, STS, MAGGIC, prognosis, NRI, IDI.

INTRODUCTION

Coronary artery disease remains the leading cause of mortality worldwide, and coronary artery bypass grafting (CABG) is one of the most effective methods of surgical myocardial revascularization. Despite significant advances in cardiac surgery, the risk of postoperative complications remains substantial and requires accurate preoperative risk stratification.

In clinical practice, prognostic models such as EuroSCORE II, STS, and MAGGIC are widely used; however, their limitations are associated with insufficient consideration of myocardial functional status. In particular, left ventricular diastolic function, which is an integral indicator of myocardial reserve, is not included in most existing models.

Left ventricular diastolic dysfunction is considered an integrative marker of structural and functional myocardial remodeling, reflecting impaired relaxation, increased myocardial stiffness, and elevated filling pressure, which leads to reduced hemodynamic reserve. It has been shown that diastolic dysfunction is an independent predictor of adverse outcomes after cardiac surgery, including mortality, prolonged mechanical ventilation, and longer hospital stay.

Clinically, it is important that LVDD is often detected in patients with preserved or moderately reduced left ventricular ejection fraction and reflects the phenotype of heart failure with preserved ejection fraction (HFpEF), which results in latent reduction of myocardial reserve and increased vulnerability under surgical stress.

Thus, there is a practical need for a simple and reproducible algorithm for personalized risk stratification of complications after CABG, complementing traditional risk scores and based on functionally significant parameters, primarily the assessment of left ventricular diastolic function.

Aim of the study: to evaluate the universal role of LVDD as a modifier of the prognostic models EuroSCORE II, STS, and MAGGIC in patients undergoing CABG.

MATERIALS AND METHODS

Study design and patients

The study included 178 patients with coronary artery disease who underwent elective coronary artery bypass grafting (CABG). Clinical, echocardiographic, and functional parameters were analyzed, including the assessment of left ventricular diastolic function, as well as integral risk scores (EuroSCORE II, STS, MAGGIC).

Depending on the postoperative course, patients were divided into two groups:

– patients with a favorable postoperative course (136 patients);

– patients with postoperative complications (42 patients).

Inclusion criteria: presence of indications for CABG; elective surgery; availability of complete clinical, laboratory, and instrumental data.

Exclusion criteria: emergency cardiac surgery; repeat cardiac surgery; acute inflammatory or infectious diseases in the preoperative period; incomplete clinical or instrumental data.

Instrumental assessment and risk scores

All patients underwent a comprehensive examination including medical history assessment, evaluation of comorbidities, laboratory tests, ECG, and Doppler echocardiography. Doppler echocardiography was performed with assessment of systolic and diastolic left ventricular function; diastolic function was assessed according to standard methodology.

To assess surgical risk and predict postoperative complications, EuroSCORE II, STS score, and MAGGIC score were calculated for all patients.

The study was conducted in accordance with the principles of the Helsinki Declaration. All patients signed informed consent.

Statistical analysis

Data analysis was performed using R and SPSS software packages. The normality of distribution was assessed using the Shapiro–Wilk test. Quantitative data are presented as median and interquartile range (Me [Q1; Q3]), and qualitative data as absolute and relative values (n, %).

Independent groups were compared using the Mann–Whitney test for quantitative variables and the Pearson χ^2 test or Fisher's exact test for categorical variables. Differences were considered statistically significant at $p < 0.05$.

To identify risk factors for postoperative complications, logistic regression analysis was performed with univariate and multivariate analysis. Results are presented as odds ratio (OR) with 95% confidence interval (CI).

The prognostic performance of the models was evaluated using ROC analysis (AUC), and model comparison was performed using the DeLong test. The additional prognostic value of left ventricular diastolic dysfunction was assessed using risk reclassification indices (NRI, IDI). The clinical usefulness of the models was analyzed using Decision Curve Analysis (net benefit).

RESULTS

Table 1.

Baseline characteristics of patients (Group 1 – without complications, Group 2 – with complications)

Parameter	Without complications (n=136)	With complications (n=42)	p
Age, years	58 [52; 64]	61 [55; 67]	0.15
Sex, n (%)	103 (75.7)	36 (85.7)	0.18
BMI, kg/m²	26.9 [24.4; 29.8]	27.2 [25.0; 30.5]	0.78
LVEDD, mm	55 [50–60]	52 [48–56]	>0.05
LVESD, mm	40 [33–45]	35 [30–40]	>0.05
IVS, mm	9.5 [10–12]	10.0 [9–11]	>0.05
LV posterior wall, mm	10.0 [10–12]	10.5 [9–11]	>0.05
LVEF, %	52 [46; 60]	45 [40; 52.8]	0.004
Heart rate, bpm	74 [65; 83]	82 [71; 91]	0.008
Left atrial diameter, mm	39 [38; 43]	43.5 [40; 47]	<0.001
Creatinine, μmol/L	90 [76; 107]	97.5 [89.8; 114]	0.025
EuroSCORE II	0.016 [0.011; 0.027]	0.0317 [0.0143; 0.0671]	0.002
STS score	0.009 [0.0065; 0.013]	0.0158 [0.0105; 0.0397]	<0.001
MAGGIC score	22 [19; 25]	24 [21; 27]	0.03
LVDD, n (%)	51 (37.8)	28 (66.7)	0.001
Diabetes mellitus, n (%)	58 (42.6)	16 (38.1)	0.52
Previous myocardial infarction	35 (25.7)	11 (26.2)	0.97
COPD	22 (16.2)	5 (11.9)	0.63
Smoking	25 (18.4)	6 (14.3)	0.64
Left ventricular hypertrophy	80 (58.8)	27 (64.3)	0.46

As can be seen from the data presented in Table 1, there were no differences between the groups in age, sex, and body mass index. The groups also did not differ significantly in left ventricular size and wall thickness, in the number of previous myocardial infarctions, in the presence of chronic obstructive pulmonary disease, diabetes mellitus, smoking status, or left ventricular hypertrophy (according to ECG data).

Statistically significant differences between the groups were found in left ventricular ejection fraction, left ventricular diastolic dysfunction, heart rate, left atrial diameter, and blood creatinine levels. All three risk scores (EuroSCORE II, STS, and MAGGIC) showed statistically significant differences between the groups.

In Table 2, the baseline characteristics of patients are presented with the indication of the standard deviation (± SD). They confirm the data presented in Table 1.

Table 2.

Baseline characteristics of patients (Group 1 – without complications, Group 2 – with complications). Values are presented as mean ± SD. Comparison was performed using Welch's two-tailed t-test.

Parameter	Without complications (n=136)	With complications (n=42)	p
BMI, kg/m²	29.1 ± 3.9	28.9 ± 4.9	0.71
LVEDD, mm	55 ± 0.66	52 ± 0.78	>0.05
LVESD, mm	40 ± 0.87	35 ± 1.09	>0.05
IVS, mm	9.5 ± 0.13	10.0 ± 0.22	>0.05
LV posterior wall, mm	10.0 ± 0.13	10.5 ± 0.22	>0.05
LVEF, %	51.1 ± 9.8	45.2 ± 11.1	0.002
Left atrial diameter, mm	39.8 ± 5.5	44.7 ± 7.9	<0.001
Heart rate, bpm	75.1 ± 13.5	83.1 ± 15.1	0.004
Creatinine, μmol/L	92.1 ± 25.6	102.9 ± 29.9	0.021
EuroSCORE II	0.016 ± 0.009	0.032 ± 0.028	<0.001
STS score	0.0095 ± 0.007	0.016 ± 0.015	0.001
MAGGIC score	21.8 ± 4.6	24.2 ± 5.3	0.007

The analyzed scores (EuroSCORE II, STS score and MAGGIC score) represent integral multiparametric models. Inclusion in the analysis of individual variables included in their structure (left ventricular ejection fraction, creatinine level) could lead to duplication of prognostic information. Therefore, we evaluated the diagnostic effectiveness of these scores with the addition of only the parameter of left ventricular diastolic dysfunction, which is not included in their calculators.

Table 3.

Diagnostic effectiveness of prognostic models according to ROC analysis and comparison using the DeLong method

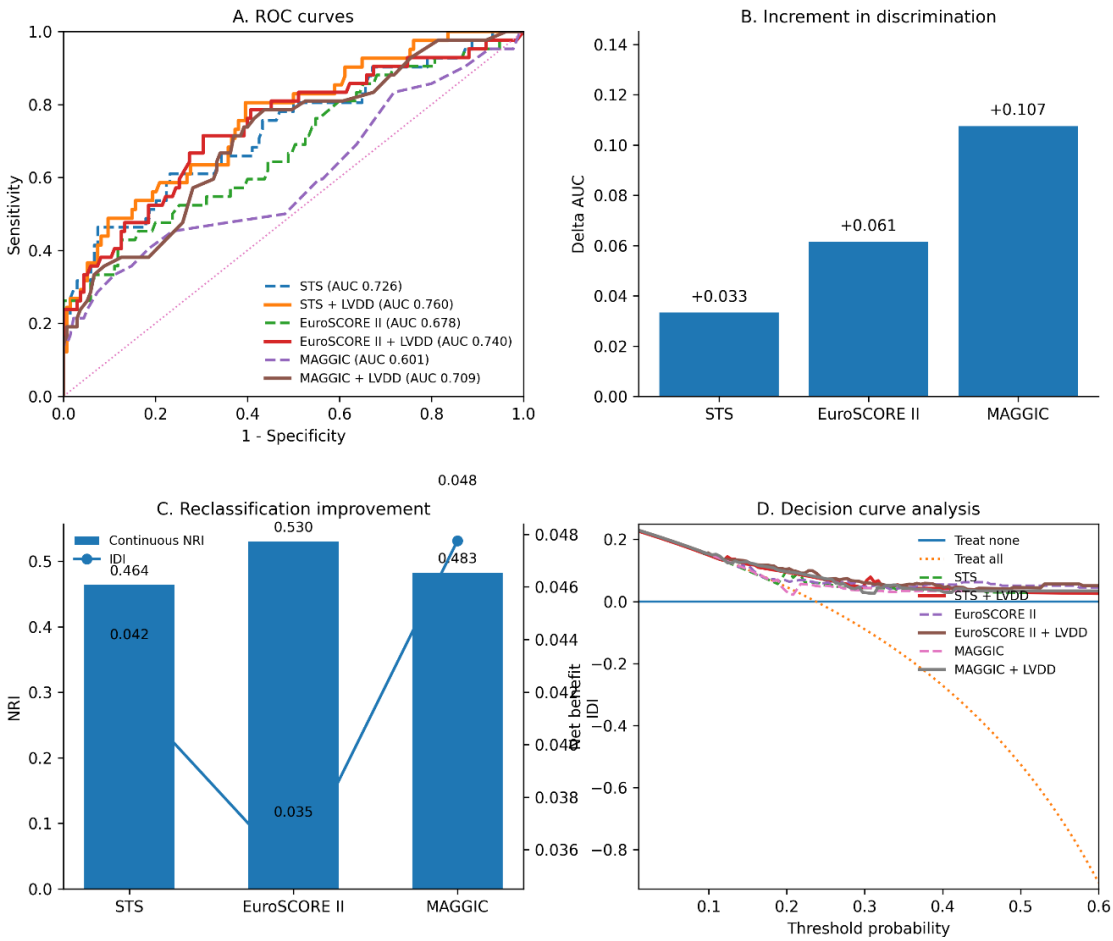
Model	AUC (95% CI)	Sensitivity (%)	Specificity (%)	ΔAUC	P (DeLong)
LVDD	0.69 (0.60–0.78)	66.7	62.2	—	—
STS	0.72 (0.64–0.80)	68.1	76.5	—	—
STS + LVDD	0.75 (0.68–0.83)	76.2	73.5	+0.03	0.041*
EuroSCORE II	0.67 (0.59–0.75)	65.4	70.1	—	—
EuroSCORE II + LVDD	0.73 (0.65–0.81)	73.8	72.1	+0.06	0.028*
MAGGIC	0.53 (0.45–0.61)	60.0	58.0	—	—
MAGGIC + LVDD	0.66 (0.58–0.74)	71.4	65.4	+0.13	0.012*

The addition of left ventricular diastolic dysfunction led to a statistically significant increase in AUC in all models ($p < 0.05$), while the most pronounced increase was observed for the MAGGIC score ($\Delta AUC = 0.13$), whereas the STS + LVDD model demonstrated the most balanced improvement in discriminative ability.

Risk reclassification analysis (NRI, IDI) confirmed a clinically significant improvement in patient risk stratification. Decision Curve Analysis showed an increase in net benefit of the combined models across a wide range of threshold probabilities.

No statistically significant differences were found between the individual clinical scores ($p > 0.05$). Similarly, comparison of the combined models also did not show statistically significant differences ($p > 0.05$).

* $p < 0.05$ — statistically significant difference (DeLong test)



Data source: cleaned cohort from uploaded Excel workbook (n=178; no complications n=136, complications n=42). Base and augmented models were fit on complete cases for each score.

Figure 1. Incremental prognostic value of left ventricular diastolic dysfunction (LVDD) added to conventional risk models in patients undergoing coronary artery bypass grafting.

(A) Receiver operating characteristic (ROC) curves demonstrating improved discrimination after inclusion of LVDD into STS, EuroSCORE II, and MAGGIC models.

(B) Absolute increase in area under the curve (ΔAUC) following addition of LVDD.

(C) Improvement in risk reclassification assessed by net reclassification improvement (NRI) and integrated discrimination improvement (IDI).

(D) Decision curve analysis (DCA) showing increased net benefit of LVDD-augmented models across clinically relevant threshold probabilities.

Addition of LVDD resulted in consistent improvement in discrimination, risk reclassification, and clinical utility across all models, with the greatest relative gain observed in the MAGGIC model, while the STS-based model demonstrated the most balanced and clinically robust performance.

DISCUSSION

In the present study, it was shown that left ventricular diastolic dysfunction (LVDD) is a significant independent predictor of postoperative complications in patients undergoing coronary artery bypass grafting (CABG). The addition of LVDD to traditional prognostic models (EuroSCORE II, STS, and MAGGIC) was accompanied by an improvement in discriminative ability, risk reclassification, and clinical usefulness, which indicates its additional prognostic value.

The obtained results confirm the concept that LVDD reflects myocardial functional reserve and integrates the influence of multiple pathophysiological factors, including age, arterial hypertension, ischemia, and metabolic disorders [9–11]. Unlike traditional risk scores, which are mainly based on demographic and clinical variables, LVDD represents a functional parameter that directly characterizes the ability of the myocardium to adapt to hemodynamic stress. This is consistent with modern concepts of heart failure with preserved ejection fraction (HFpEF), where impaired diastolic function plays a key role in clinical outcomes [9,12].

Clinically, it is important that LVDD is often detected in patients with preserved or moderately reduced left ventricular ejection fraction, which reflects the phenomenon of a "hidden" decrease in myocardial reserve. Population studies have shown that diastolic dysfunction is associated with the development of heart failure and increased mortality even in the presence of normal systolic function [13].

Under conditions of surgical intervention, accompanied by fluctuations in preload and afterload, systemic inflammatory response, and activation of neurohumoral mechanisms, it is the decrease in diastolic reserve that may limit the adaptive capacity of the heart and contribute to the development of complications. Previous studies have shown that diastolic dysfunction is an independent predictor of adverse outcomes after cardiac surgery, including increased mortality, duration of mechanical ventilation, and length of hospital stay [7,16,17].

Of particular importance are the results of the analysis of prognostic models. Despite a moderate increase in the area under the ROC curve (AUC), the addition of LVDD led to a significant improvement in risk reclassification, which was confirmed by positive NRI and IDI values (see Fig. 1). This emphasizes the limitations of using only AUC to assess the prognostic value of new markers and is consistent with modern recommendations for evaluating risk models, where particular attention is paid to the ability of the model to correctly reclassify patients between risk categories [6].

Decision Curve Analysis demonstrated that inclusion of LVDD provides a higher net benefit in a clinically significant range of threshold probabilities compared with the baseline models (see Fig. 1). This indicates that the use of LVDD can not only improve the statistical characteristics of the models but also improve the quality of clinical decision-making in the preoperative period, which is consistent with modern approaches to assessing the clinical usefulness of prognostic models [14,15].

Interestingly, the greatest relative increase in discriminative ability was observed for the MAGGIC model, whereas the STS + LVDD model demonstrated the most balanced characteristics. This may reflect differences in the initial structure of the models: in particular, the STS model already includes a wide range of clinical variables, whereas the MAGGIC model was originally developed for a population of patients with chronic heart failure.

It is fundamentally important that none of the widely used prognostic scores, including EuroSCORE II, STS, and MAGGIC, include direct indicators of left ventricular diastolic function. The obtained data demonstrate that the inclusion of LVDD makes it possible to fill this gap and add a new, independent layer of risk information that is not covered by traditional variables.

The practical significance of the results lies in the possibility of integrating the assessment of diastolic function into preoperative risk stratification algorithms. This may contribute to more accurate identification of high-risk patients, optimization of management strategies, and potentially reduce the incidence of complications.

Thus, LVDD is a universal functional risk modifier that increases the accuracy and clinical applicability of existing prognostic models in patients undergoing CABG.

The limitations of the study include a single-center design and a relatively limited sample size. In addition, the assessment of diastolic function was based on standard echocardiographic parameters, which may be subject to inter-operator variability. Further multicenter studies are required to validate the obtained results and to determine the optimal ways of integrating left ventricular diastolic dysfunction into clinical risk models.

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PEDAGOGICAL SCIENCES

DIRECTIONS FOR REGULATING THE ENVIRONMENT THAT AFFECT THE DEVELOPMENT OF STUDENTS' SKILLS ADEQUATE TO THE CHALLENGES OF MODERN SOCIETY

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Abstract

The research shows that in the current system of socio-economic relations—the "techno-democratic information society"—the intellectual and creative activity of everyone living in it becomes a paramount requirement. For this reason, it is desirable for every member of society to rise to the level of a subject possessing intellectual skills; they must have an information culture and technological literacy.

The research presents the characteristics of "Education 4.0", which provides an effective environment for the formation of students' technological literacy and information culture, as well as the groups of intellectual skills that must be formed in this system, formulated on a certain logical basis.

The research paper highlights that these tasks are designed based on the principle of modeling the structure of various intellectual skills. As students complete them, they acquire intellectual skills such as determining the purpose of their work, systematizing educational material from this perspective, independently collecting material, etc.

The research focuses on the didactic principles necessary for the selection and systematization of tasks to be applied in order to form and develop students' technological literacy and information culture, as well as for organizing students' activities based on them.

Keywords: modern society, system of socio-economic relations, technological literacy, information culture, intellectual skills, metacognitive skills, creative thinking, idea, task.

Relevance of the topic. The characteristics of the 21st century (the modern era in which we live) require that a person develop the qualities necessary for creative activity (decision-making, problem-solving, independent learning, cooperation, teamwork, evaluating different approaches, putting forward new ideas, taking initiative, etc.), as well as the skills needed to live and progress in a rapidly changing and developing world. This creates conditions for sustainability in the future development of modern society.

In the modern era—the "techno-democratic information society"—everyone living in it must engage in intellectual and creative activity. For this, a person must rise to the level of a subject possessing technological literacy, information culture, and intellectual skills. Therefore, it is necessary to determine optimal ways to acquire technological literacy, information culture, and intellectual skills and to regulate the environment that includes such adequate approaches.

However, the methodological system for solving such a cognitive problem (of a pedagogical nature) has not been developed on a sufficiently scientific basis. Based on the above arguments, we emphasize the relevance of studying the topic "Directions for Regulating the Environment that Affect the Development of Students' Skills Adequate to the Challenges of Modern Society."

The purpose of the study is to identify ideas about the directions for regulating the environment that affect the development of students' skills in the process of implementing general education in line with the challenges of modern society—in other words, the development of students' technological literacy, information culture, and intellectual skills.

It is taken into account that an idea is an important value: the world of human activity is always based on ideas, and everyone takes steps to verify the adequacy of the results of their activity in relation to the idea they consider acceptable.

Methodological basis of the study. In the process of conducting the research, the following served as the methodological basis: L. Bertalanffy's "Idea of System Analysis" [2;8] (an idea whose meaning is explained as an attempt to study the properties of an object based on the properties of its parts), the system-structural approach, which has been formed as an important branch of dialectics and has risen to the level of its alternative, empirical, empirical-theoretical, and theoretical methods of scientific cognition, the internal relationships of

the forms of scientific cognition, and various pedagogical and psychological research generalizations.

Interpretation of generalizations from research materials. The characteristics of modern society (the century in which we live) require that a person develop the necessary qualities for creative activity (decision-making, problem-solving, independent learning, cooperation, teamwork, evaluating different approaches, putting forward new ideas, taking initiative, etc.) in order to live and progress in a rapidly changing and developing world. This creates conditions for sustainability in the future development of society.

It is undeniable that education, which is a process of sharing human experience, has developed in stages, incorporating the characteristics of industrial revolutions, as a product of social practice (specifically, pedagogical science). The era of the Fourth Industrial Revolution requires an education system that can shape a generation that is creative, innovative, and globally competitive. Currently, the impact of the aforementioned revolution on education and the issue of the "education of the future" are being discussed on various platforms, and appropriate necessary steps are being taken. [11], [12; 92–97]

The Fourth Industrial Revolution is having an impact on the education system as well as on socio-economic spheres. In line with the industrial revolutions, "education, which is a process of sharing understanding and exchanging experience," has developed in stages (including the specific characteristics of industrial revolutions). It is worth emphasizing that the expected paradigm shifts in the education system and the implementation of global education reforms have been further accelerated by the impact of the Fourth Industrial Revolution. [21; 147–171]

The Fourth Industrial Revolution has different implications for different areas of our lives. From this perspective, there are both opportunities and challenges for education. The use of different technologies such as IoT, 3D printing, quantum computing, artificial intelligence, etc., allows for more effective transmission of information and the development of a new "educational framework." [14; 78–94]

It is necessary to distinguish two main reasons for the reforms carried out in the education system and its implementation system in connection with the challenges of the Fourth Industrial Revolution. The first is the training of a workforce that has the knowledge (information) and skills required to meet the needs of a rapidly changing global economy. The second is the establishment of an education and implementation system capable of producing the productive forces (labor force) necessary for the development of an adequate information society during the industrial revolution. [9; 288]

In a "techno-democratic information society," intellectual and creative activity becomes a paramount requirement for everyone living in it. For this reason, it is desirable for every member of society to rise to the level of a subject possessing intellectual skills; they must have information culture and technological literacy. Information culture:

- is the knowledge, intellectual skills, and habits necessary for a person to adapt to the information society;
- is the ability to use the information resources and information communication tools of society;
- is the application of advanced achievements in the field of informatization and the development of information technology tools in society;
- is the ability to obtain and transmit information using modern technical means and methods, including computer technologies.

Technological literacy is the ability of people to use various digital technologies, analyze information, and operate safely in a digital environment. "This skill is not limited to using a computer and the internet, but also includes: 1. adherence to digital security and cybersecurity rules; 2. working with artificial intelligence and automation; 3. digital analytics and data processing skills; 4. using cloud technologies; 5. quickly adapting to new technologies." [5] Technological literacy includes the ability to use information and communication technologies.

Developing digital skills is essential to ensure that individuals can safely and effectively engage with digital technologies in the future. Education systems need to take a comprehensive and holistic approach, supporting all learners in developing the skills necessary to be active and ethical users of digital technologies. [17; 57–79]

Digital education allows people to participate independently in social life. In addition, the reality of digital education and the digital revolution requires fundamental changes in the forms and methods of moral acquisition, leading to the emergence of digital skills as the most important ability. [16; 58–64] There is no doubt that developing students' digital skills will lead to their more active participation in society as digital citizens in the future. [15], [17; 57–79]

Due to the rapid development of technology, the knowledge and skills that students learn during their education become obsolete by the time they graduate. In scientific and technical education, it is necessary to educate students and prepare them for the digital environment in order to help develop and shape the use of today's fastest-growing technologies. Adapting to a rapidly changing environment will require students to engage with educational institutions even after graduation, providing both workers with updated skills and young students (and faculty) with a new perspective on the rapidly changing realities of the industrial and corporate sectors. [18; 25–30], [19; 579–592]

It is undeniable that there is specificity in the challenges of each industrial revolution. This is manifested against the background of global changes taking place in the world, and at the same time it determines the emergence of new dimensions in information culture and the content of technological literacy. At different stages of world history, humanity has faced serious changes and achieved results through the reforms carried out. In order for students to be able to demonstrate their skills and abilities in new fields emerging under the influence of the Fourth Industrial Revolution, it is necessary to implement fundamental changes in technology and taught subject programs. By reviewing the

curricula of subjects based on chemistry, biology, physics, etc., which are considered "basic sciences" in the new curricula, more attention should be paid to teaching computer science subjects, which play a key role in the formation of the literacy required for the Fourth Industrial Revolution. Naturally, greater attention should be paid to teaching these subjects. [20; 432–466]

Against the backdrop of industrial revolutions, educational program developers had to seek answers to the following fundamental questions: 1. What knowledge, skills, and values should be reflected in educational programs? 2. Will these knowledge, skills, values, and competencies form the necessary life skills in learners? 3. How can the process of implementing education be made relevant and interesting for learners? 4. How can assessment (an integral part of the process of implementing education) be made more productive and effective?

In our modern era, parameters such as relevance, practicality, effectiveness, and sustainability are the focus of attention as indicators of the quality of an educational program, while the indicator of its success is the quality of acquisition by learners and the extent to which learners can effectively use what they have acquired for their personal, social, cognitive, psychological, and emotional development.

UNESCO has the following criteria for a quality education program: the educational program must have clear objectives; meet the demands of today; be relevant to the current and future lives, experiences, desires, and aspirations of learners; aim to build a prosperous future for learners in social and economic terms, taking into account the history and culture of the country in which they live; be fair and inclusive (taking into account the individuality and individual needs of learners, etc.); be learner-centered (taking into account the needs of the learner, being appropriate to the learner's age, helping in personal development and the formation of life skills, and not overloading learners); be open and flexible (integrating emerging innovations into the content); and be consistent and relevant. [3; 5]

Education 4.0 should serve to develop the skills (intellectual skills) necessary to use new technologies that help learners develop in accordance with changes in society. It should form knowledge and skills that learners can use throughout their lives, not limited to reading and writing. Thus, the system should respond to changes in the social and economic environment in order to meet the needs of human capital. Education 4.0 aims to prepare individuals to be creative and innovative. Education should adapt to the environment in which learners live, providing them with a secure and successful future. This new system uses "smart" school management systems, learning management software, communication tools, and teaching and learning tools. [13; 238–254]

In the Education 4.0 approach, moving beyond constructivist education systems and Bloom's taxonomy, it has been determined that an environment—a teaching process—aimed at the formation and development of intellectual skills should be implemented based on the following directions: 1. 3R, which regulates understanding (Recalling, Relating, Refining); 2. 3I, which encourages inquiry (Inquiring, Interacting, Interpreting); 3. 3P, which is based on drawing conclusions (Participating, Processing, Presenting). [22; 92–98], [23; 40–45]

Education 4.0, which provides an effective environment for the formation of intellectual skills, has the following characteristics: 1. Learning regardless of time and place (lifelong learning, e-learning, etc.); 2. The opportunity to receive personalized education according to the skills and abilities of students; 3. Taking into account the suggestions of students when preparing the curriculum; 4. The predominance of project-based learning; 5. The formation of students' ability to conduct analysis on large-scale data (Big Data); 6. Assessment of students' knowledge through the process of applying them to projects; 7. Becoming part of the education system that develops new technologies, etc. [11–12]

Scientific sources indicate that in the process of implementing general education, a student must acquire the necessary intellectual skills in order to realize his or her intellectual abilities and purposefully regulate cognitive activity. Intellectual skills are numerous. Taking into account N. A. Menchinskaya's research in this area, intellectual skills can be divided into the following groups: 1. General intellectual skills (planning, working with a book, self-control); 2. Intellectual skills necessary for the organization of mental activity (distinguishing the main idea in a text, dividing the text into parts according to meaning, comparing events, etc.); 3. Specific intellectual skills (reflecting the characteristics of a particular subject, for example, graphic skills). Another classification of intellectual skills, authored by I. Unt, is as follows: 1. Skills related to the perception of educational material (reading, observation, listening skills); 2. The ability to perform logical operations with educational material (the ability to identify what is important, compare, draw conclusions, etc.); 3. Creative skills (the ability to build a composition, etc.). [1; 60]

It is worth noting that human self-awareness has always been an urgent problem in world philosophy, psychology, and pedagogy. Scientists have approached human self-awareness from the perspective of personality, seeking its roots in the process of forming a person's ideas about his or her own "I." Unfortunately, until recently, researchers have not sufficiently appreciated a person's understanding of the characteristics of his or her own mental world, the world of thinking, and cognitive processes. In contemporary American psychology, this issue has been brought into the spotlight and studied as a metacognitive system. It has been established that as children develop, they form certain ideas about cognitive (perception) processes and begin to regulate their own mental activity. It is worth emphasizing that self-monitoring, self-regulation, and self-assessment are metacognitive skills and are related but distinct concepts. They represent a person's awareness and understanding of the processes of self-awareness.

Flavell has studied and described in detail some of the functions of metacognition. Among them are the following: 1. Problem formulation and identification of possible solutions; 2. Knowing which cognitive processes are necessary to solve a task; 3. Activation of

cognitive rules and methods; 4. Confidence in the capabilities of thinking; 5. Attempting to solve tasks more efficiently.

These functions are interconnected. The first function is conditioned by the formation of ideas about the goals of activity in children. As they grow older, they learn to apply known methods to various situations. Gradually, students develop ideas about cognitive processes. [1; 60], [7; 74]

A system of special tasks is applied in order to form intellectual skills (determined by the requirements of the modern era) in students. These tasks are designed according to the principle of modeling the structure of various intellectual skills. As students complete them, they acquire intellectual skills such as determining the purpose of their work, systematizing educational material from this perspective, independently collecting material, writing an essay, etc. From the perspective of the principle of developmental learning, this approach is considered effective. However, in order to use it purposefully, the system and content of intellectual skills across grades and subjects must be thoroughly developed.

Tasks and their system should: be consistent with the purpose of the lesson and aimed at solving the research problem set (according to the type of thinking, information sources, form of presenting results, etc.); be appropriate to the age, knowledge and intellectual level, abilities and interests of students, and be differentiated; be based on the state program and national values; be relevant and related to real life and students' experiences; be interesting and attractive, and encourage discovery; be clearly stated; and contain clear and open questions.

It is possible for a student to act in the position of a researcher when the content of the training material and the form of action of the means and methods (in the training process, the content of the training material, the means and methods take the place of content in relation to the organizational form) are consistent with the research process. If we accept that the organizational form of training organized in accordance with the research process has a unique structure and resembles the stages of the research process, we will not have made such a serious mistake.

The following principles should be kept in focus when selecting and systematizing tasks to be applied for the purpose of forming intellectual skills and organizing students' activities based on them: completeness of the learning process; creation of equal opportunities in learning; student-centeredness; development orientation; stimulation of activity; and creation of a supportive environment.

Scientific novelty of the research. The idea of the directions of pedagogical influence aimed at the formation of students' intellectual skills in the process of implementing general education has been identified.

The theoretical significance of the study is that research on the presented topic has a special function in creating conditions for sustainability for the future development of society and in directing further scientific activity toward a broad study of theoretical and practical ways to solve the problem.

The practical significance of the research is that in the real pedagogical process, practical educators have the opportunity to benefit from the idea of the directions of pedagogical influence aimed at the formation of students' intellectual skills in their activities.

Conclusion. 1. At the modern stage of socio-economic development, the intellectual and creative activity of everyone living in the "techno-democratic information society" becomes a paramount requirement, and for this it is necessary for every member of this society to rise to the level of a subject possessing intellectual skills; 2. The existence of information culture and technological literacy in every member of a society formed in accordance with the challenges of the Fourth Industrial Revolution is a desirable quality; 3. The education system adequate to the "techno-democratic information society" has taken its place in scientific sources and pedagogical practice under the term "Education 4.0" and has been interpreted as a superstructure on logical grounds; 4. "Education 4.0," which provides an effective environment for the formation of intellectual skills, has specific characteristics, and it is possible to divide the intellectual skills that need to be formed in this system into groups on a certain logical basis; 5. In general education schools, a system of special tasks is applied to form intellectual skills in students, and it is advisable to design these tasks based on the principle of modeling the structure of various intellectual skills; 6. In selecting and systematizing tasks to be applied for the purpose of forming intellectual skills and organizing students' activities based on them, the following principles should be kept in focus: 1. Completeness of the educational process; 2. Creating equal opportunities in education; 3. Student orientation; 4. Development orientation; 5. Stimulation of activity; 6. Creating a supportive environment.

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A COMPARATIVE STUDY ON MENTAL HEALTH AMONG UNIVERSITY STUDENTS IN CHINA AND KAZAKHSTAN: INTEGRATED INTERVENTION OF TRADITIONAL PHILOSOPHIES AND POSITIVE PSYCHOLOGY

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Abstract

Mental health problems among university students have become a common public health issue around the world. This study uses the Depression–Anxiety–Stress Scale (DASS-21) to compare mental health conditions between 1912 Chinese university students and 1024 Kazakh university students. Results show that the detection rates of depression (42.5%) and anxiety (60.2%) are significantly higher among Chinese students, while the detection rate of stress (40.5%) is significantly higher among Kazakh students. Based on respective cultural traditions, this study integrates Wang Yangming's Psychology of Mind and Ahmad Yasawi's Sufi thought with positive psychology to build culturally adapted intervention models. Findings show that traditional philosophical ideas effectively support mental health improvement. In addition, China and Kazakhstan can strengthen mutual learning and cross-national cooperation under the Belt and Road Initiative to jointly promote the healthy development of youth mental health.

Keywords: China–Kazakhstan comparison; mental health; university students; Wang Yangming's Psychology of Mind; Ahmad Yasawi; traditional philosophy; positive psychology; DASS-21

Introduction

Mental health problems among university students have drawn wide global concern. As close strategic partners, China and Kazakhstan present different mental health characteristics shaped by social, cultural and educational environments. Chinese students face relatively high levels of anxiety and depression due to long-term academic competition and social pressure [13]. According to Li, Confucian self-cultivation provides a unique cultural path for regulating negative emotions among college students [8]. For Kazakhstan, university students experience obvious pressure from social transformation and educational reform [1]. However, positive psychology cannot fully achieve expected effects without cultural adaptation in non-Western contexts [11]. Juraev and Rajavaliev pointed out that Sufi thought of Ahmad Yasawi contains rich psychological wisdom for emotional balance and inner peace [6]. Wang also supported that traditional Eastern philosophies share high consistency with positive psychology mechanisms [14]. This study compares mental health differences between Chinese and Kazakh students and explores integrated intervention models with a focus on mutual learning between the two countries.

Materials and Methods

Participants

The Chinese sample included 1912 university students recruited through a cross-sectional survey. The Kazakh sample included 1024 university students, with data obtained from a published empirical study [1].

Research Tool

The Depression–Anxiety–Stress Scale (DASS-21) was used to measure mental health status. The scale includes three dimensions and has been widely used and verified in cross-cultural youth groups.

Data Analysis

Descriptive statistics and chi-square tests were used for between-group comparisons. A p value less than 0.05 was considered statistically significant.

Results

Table 1 shows significant cross-national differences in mental health indicators. Chinese students have higher detection rates of depression and anxiety, while Kazakh students have a significantly higher rate of stress. Stress has become the most prominent mental health problem among Kazakh university students [1]. These differences reflect different social and cultural pressure sources. Chinese students study in a highly competitive academic atmosphere, while Kazakh students are in a period of rapid social change and cultural

adaptation. Such differences indicate that culturally appropriate mental health interventions are urgently needed.

Table 1

Comparison of Mental Health Indicators Between Chinese and Kazakh University Students

Domain	Chinese Students (%)	Kazakh Students (%)	Characteristic
Depression	42.5	36.8	Higher in China
Anxiety	60.2	38.1	Significantly higher in China
Stress	33.5	40.5	Significantly higher in Kazakhstan
Sample Size	N = 1912	N = 1024	—

Integrated Intervention of Traditional Philosophies and Positive Psychology

Wang Yangming's Psychology of Mind and Positive Psychology

Wang Yangming's Psychology of Mind is a typical Confucian philosophical system that focuses on internal self-improvement and emotional adjustment. Song, Jiang and Liu clearly stated that Wang Yangming's Psychology of Mind can effectively relieve anxiety and depression among college students by adjusting cognition and emotion [13]. Its core ideas include "Mind is Principle," "attainment of innate conscience," and "unity of knowledge and action." Li pointed out that these ideas correspond well to cognitive reappraisal, meaning construction and resilience training in positive psychology [8]. Wang also confirmed that Confucian ideas help individuals form stable mental states and improve psychological resilience [14]. This philosophy encourages people to observe inner changes, correct unreasonable thinking, reduce excessive anxiety through self-reflection and daily practice. By combining introspection, goal setting and behavioral practice, the integrated model can reduce negative emotions and promote healthy psychological development.

Ahmad Yasawi's Sufi Thought and Positive Psychology

Ahmad Yasawi's Sufi thought is an important spiritual and cultural heritage in Central Asia. Juraev and Rajavaliev emphasized that Sufi thought guides people to control excessive desires, purify the soul and keep inner peace [6]. It focuses on spiritual purification, emotional balance, self-reflection and inner harmony. These views are highly consistent with stress coping, emotional release, mindfulness therapy and well-being promotion in positive psychology. Traditional cultural ideas are well accepted by Kazakh students and can effectively reduce stress responses [1]. This tradition helps people reduce pressure from desire and comparison, ease inner conflict and maintain stable mental state in a changing society. For Kazakh university students, this philosophy provides a natural and acceptable cultural resource for stress intervention. Through practicing self-control, tolerance and spiritual balance, the integrated model can reduce stress, improve adaptability and enhance life satisfaction.

Mutual Learning and Practical Cooperation Between China and Kazakhstan

China and Kazakhstan can achieve strong complementarity in mental health education through mutual learning. China can learn from Kazakhstan's experience in integrating national spiritual culture into mental health services to improve cultural adaptability. Kazakhstan can learn from China's systematic application of traditional philosophy and mature positive psychology intervention models. Kuanyshbek believed that modern educational technology can help improve the effect of psychological intervention [7]. Agymbaikyzy proposed that interactive and participatory teaching methods are more suitable for contemporary college students [3]. Orazbek, Amanbayeva and Tokbergen emphasized that AI-based teaching tools can improve the efficiency and accessibility of mental health education [10]. The two countries can strengthen cooperation in curriculum development, digital teaching tools, teacher training and cross-cultural research. Joint efforts will help build a cross-cultural mental health system and support the healthy growth of young people under the Belt and Road Initiative.

Conclusions

1. Mental health conditions differ significantly between Chinese and Kazakh university students. Chinese students are more affected by anxiety and depression, while Kazakh students face more serious stress problems.
2. Wang Yangming's Psychology of Mind and Ahmad Yasawi's Sufi thought are highly compatible with positive psychology and can be used as effective localized intervention resources.
3. Integrated intervention models based on traditional philosophies are scientific, culturally appropriate and practically sustainable.
4. China and Kazakhstan can learn from each other's strengths in culture, education and psychological practice to achieve complementary development.
5. Cross-national cooperation and mutual learning provide an effective way to improve mental health services and support long-term youth development in both countries.

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SOME METHODOLOGICAL ISSUES FOR FOREIGN LANGUAGE TEACHERSS

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Abstract

The objective of the present paper is to offer new model of ME teacher with knowledge and qualifications necessary for the demands of the modern world, the specialists with appropriate education and practical training in Maritime field. Our intention is also to offer development of new curriculum for ME teachers' training to make them as well-trained as possible so that they can render knowledge of English and of the subject to their students in the best possible way. It is also our goal to develop a new curriculum for the training of maritime English Professionals, to ensure that they transfer their knowledge of the English language and the relevant industry in the most effective way.

For writing the present paper we have analyzed a lot of articles dedicated to such subject as phenomenon of ESP teacher, we considered the existing types of teachers involved in teaching ESP and ME in particular and on basis of this comparison we offered new model of ME teacher who is supposed to receive type of qualification on basis of offered curriculum containing specific subjects from different disciplines of Maritime field in native and English languages. In order to correlate the successful work of the teacher with the level of preparation of the students as from linguistic as well from professional points of view we have worked out the best possible models that would guarantee maximally successful cooperation between teachers and students for the purpose of receiving the best possible results in the process of studies.

Keywords: maritime English, efective way of teaching, language teachers.

Introduction

The field of ESP is very important part of English language teaching as it guarantees the knowledge of English for professionals of different fields that is essential in the era of globalization. ESP comprises different fields: English for Medicine, English for Engineering, English for Social Sciences, English for Maritime field, etc. The quality of knowledge of English by specialists in their professional scope depends on the quality of teaching they have received that is in its turn dependent on the knowledge and qualifications of teachers responsible for teaching students i.e. on the ESP teachers and ME teachers if considered in the context of Maritime field.

The objective of the present article is to offer model of ESP teacher and ME teacher in particular to meet demands of maritime field in the modern world. For this purpose, we have considered all existing types of teachers who teach English for Specific Purposes in our country and offered the new model for preparation of ESP teachers and also tried to develop sketches of the curriculum according to which the ESP teachers can receive adequate training to be able to teach English to their students on the proper level. We have also discussed the models of ESP students and correlated the models of ESP teachers to ESP students to try to single out the best variants whose cooperation in the teaching/learning process would result in good students' knowledge of English in the professional context. It is worth mentioning that the main aim of the present paper is to consider Maritime English and offer new model of ME lecturers although we consider ME in the ESP context as it belongs to it.

Methodology

For writing the present paper we have analyzed a lot of articles dedicated to such subject as phenomenon of ESP teacher, we considered the existing types of teachers involved in teaching ESP and ME in particular and on basis of this comparison we offered new model of ME teacher who is supposed to receive type of qualification on basis of offered curriculum containing specific subjects from different disciplines of Maritime field in native and English languages. In order to correlate the successful work of the teacher with the level of preparation of the students as from linguistic as well from professional points of view we have worked out the best possible models that would guarantee maximally successful cooperation between teachers and students for the purpose of receiving the best possible results in the process of studies.

Analysis of Research

ESP is equally important for such basic linguistic activities as teaching and translation although in case of the latter it is more often referred to as specialized English. Such issue as models of ESP teacher implying: 1) EFL teacher with practical experience in ESP, and 2) subject teacher with knowledge of foreign language is actual. In addition to the existing models of ESP teachers, linguists or specialists of specific fields we decided to develop a new model of ESP teacher or ME teacher in particular who after receiving certain qualifications would be able to meet the needs of ESP students at higher education institutions.

The same can be observed in the field of Maritime education. Maritime English is a branch of ESP, officially adopted by IMO as means of communication between seafarers all over the world. Successful knowledge of ME can be guaranteed only if cadets are taught it on the proper level by adequately qualified language specialists. Nowadays ME is taught either be EFL teachers with experience of teaching ME in maritime institutions or by professional seafarers. Captains,

chief officer, after receiving language certificates work as ME teachers thus teaching ME to the students.

As our objective is to consider phenomenon of ESP teacher and offer the new model of ESP teacher and ME teacher in particular we decided to consider this phenomenon in the context of its related issues such as, ESP methodology, ESP text (adapted and authentic), ESP terminology and support our ideas by opinions of different scientists who have been considering this subject during last 30 years. All these issues being part of ESP prepare the reader of the present article to percept the main subject of the paper – new model of ME teacher.

Our objective is to offer a new model of ME teacher implies teacher with education both in linguistic field and maritime subjects as well the experience in maritime field to make them more qualified for ME teaching and guarantee that their lectures are maximally interesting and fertile for future specialists of maritime field.

Nowadays the majority of ESP teachers are ordinary English teachers with experience in certain specific field. The other alternative is subject teacher with knowledge of English but due to legislative norms actual percentage of the occupancy of such specialists in teaching ESP is much lower than of EFL teachers. In my opinion ESP lectures can be delivered by both of the above-mentioned types of teachers. They can interchange each other and that would depend on the topic and material to be rendered or they can just cooperate, supplement each other and thus make the lectures and material as useful and as interesting to students as possible. Our opinion can be supported by extract from the article "Role of Functional Academic Literacy in ESP Teaching": Collaborative work (Team teaching); Chen (2000) holds that the language teacher should not be expected to possess sophisticated content knowledge, but basic concepts are needed to design an ESP syllabus that backs up the content course. Indeed, language teachers have not been trained to teach content subjects but they could definitely be a competent ESP teacher if they participate in content teaching classes and thus develop the flexibility to undergo disciplinary acculturation. In this regard, the content teacher shares the responsibility not only of providing opportunities for the language teacher to overcome the fear of a lack of content knowledge but also of introducing him/her to the modes of disciplinary thought and values. Therefore, language teachers can ask for assistance from content teachers. When this is the case, it is possible, through collaboration and cooperation, for both language and content teachers to develop the confidence and the competence to effectively integrate language and content instruction in ESP teaching, which entails 1) analysis of texts, materials, and curriculum; 2) classroom observation, reflection, and feedback; 3) collaborative action research and reflection; 4) development of integrated or complementary lessons, materials, or curricula; 5) collaborative or team teaching (Crandall, 1998). [2:402]

On account of teaching ME the similar situation was described by C. Cole, P. Trenkner, B. Pritchard in the article "Profiling the Maritime English Instructor": A noteworthy procedure where general English teachers who wish to become qualified Maritime English instructors is applied at the Qingdao Ocean Shipping Mariners College (QMC), P.R. China. The corresponding teacher is supervised by an experienced Maritime English lecturer and has to acquire or upgrade her/his maritime background knowledge by attending specific courses performed at the College. Then s/he has to embark on a vessel, be it a training ship or an active merchant ship, for a contracted period of time, at least three months. After this s/he has to sit an examination designed to assess the general maritime and specific Maritime English knowledge acquired. Having successfully passed all these steps, only then will the employee be entitled to be called a Maritime English lecturer and to teach Maritime English to nautical and/or engineering degree courses, and (sic!) at an increased hourly rate". (7:4)

In the article "Maritime English Instruction – Ensuring Instructor's Competence" the same authors offer classification of existing types of ME instructors that in our opinion should be just cited here: "1. Career specialists: These persons are recognised as they are Graduates/Qualified Teachers, have become "marinated" – have seafaring credibility, have a reasonable institutional standing, may (or may not) be "qualified" to teach ME. 2. English language and literature graduates: are lovers of English, are not necessarily interested in applied linguistics, prefer to teach general English, are often asked to teach ME but fail to meet the STCW standards. 3. Former seafarers: are technical experts but not necessarily skilled at English, not necessarily skilled at teaching, often over-challenge their students, could deliver technical subjects in English. (5:128-130)

The model of the teacher we intend to suggest implies the basic knowledge of special maritime subjects by the teacher of English. This kind of teacher will be able to deal with technical phenomena, will be aware of basic terms in all specific maritime fields and being prepared for each lecture will be able to find the meaning of any new term and it will be much more understandable to such specialist than to ordinary EFL teacher. We would like to mention that the idea of writing the present article was inspired by various scientific works, one of them is "ESP in-service teacher training programs" by Peyman R. in which the author mentions**:** **"**English major ESP instructors can fulfill course goals much better than specialists in the field provided that they possess a certain level of background knowledge in their students' academic subjects of ESP teaching in order to meet this challenge. In other words, ESP teachers are supposed to be knowledgeable in content areas as well and be able to elicit knowledge from students. However, language teachers are trained to teach linguistic knowledge rather than a content subject. Hence, they may be insufficiently grounded to teach subject matters (Richards & Rodgers, 2001)". [10:280]

When it comes to ME in particular it is relevant to bring the words of the above-mentioned scientists. Thus Clive Cole, Peter Trenkner, Boris Pritchard in their articles: "Profiling the Maritime English Instructor", "Maritime English Instruction – Ensuring Instructor's Competence", "The Profile of an Integrated Maritime English Lecturer – Status-quo and Nice-to-have"

address the phenomenon of ME teacher whereas we try to offer the model of education for ME lecturer that would help to meet demands of the field. It is worth noting that these scholars mention the issue in the article "Profiling the Maritime English Instructor" in the following way: "If the majority of institutions were to promote and encourage Maritime English qualifications many of today's problems would be solved and this paper made redundant. However, reality looks quite different. Thus, one of the goals of this initiative is to investigate why this is the case". This would be really necessary as "teachers of Maritime English, just like all other instructors involved in the education and training of seafarers, have to comply with the STCW 1978, as amended, which requires, that "instructors, supervisors and assessors are appropriately qualified for the particular types and levels of training or competence or assessment …. of seafarers either on board or ashore. (6:154)

Discussion of models of ESP teachers both the existing ones and the newly offered one entails consideration of such issues as design of curriculum for ESP teachers of newly offered model, singling out the models of students according to their knowledge of English and of the subject, discussion of peculiarities of specific texts and analyzing the ways of teaching specific terminology that is the most important part of any specific text and consequently is major task for ESP teacher during the work in the class.

We would like to offer that some Maritime educational centre or institution assumes designing a program i.e. curriculum for Maritime Engish teacher so that linguistic and specific maritime educations are combined within this program. In our opinion the educational program should be linguistic one containing basic maritime subjects of all maritime disciplines within its curriculum.

ME teacher educated according to new model of education would be successful at teaching ME and also at teaching ME through methodology of Content and Language Integrated Learning (CLIL). Such education will help to render ME more efficiently not only on the level of specific texts containing important information but also on the level of SMCP as the more the teacher visualizes the situation the better he/she can explain it. At present there are no maritime higher education institutions in the world implementing such programs, the only one is mentioned by C. Cole, P. Trenkner and B. Pritchard in their article "Profiling the Maritime English Instructor": "An interesting and attractive qualification system is applied, for instance, at Danish MET institutions. Here deck, engineer or former radio officers possessing an extraordinarily high standard of English and wishing to teach Maritime English have to take a reduced, but more than basic, extramural course of two years following an individually tailored programme which includes methodology, (applied) linguistics, curriculum development etc., at a specified university which is authorised to perform such. All the courses are paid for by the corresponding maritime academy and the time spent is counted as work time". (7:6-7)Our offer is to integrate similar program at some maritime higher education institution for English language specialists in order to teach them the basics of Maritime field.

The knowledge of the subject by ESP/ME teacher is very important especially when dealing with terminology of certain field. Terminology is studied much better when its essence is familiar to the teacher and the learner. Therefore, the competency of the teacher is that important. In our opinion, it is more efficient to teach terms via bilingual technical dictionaries and English-English explanation could be studied when translation of the term is already familiar to the learner. Different scientists had different opinions on account of teaching technical vocabulary. We would like to mention some of them: "Swales (1985) proposed that the importance of teaching vocabulary in ESP is widely accepted. However, Hutchinson and Waters (1987) believed that the teaching of technical vocabulary is not the responsibility of the ESP teacher. With regard to dealing with unfamiliar technical vocabulary in ESP classes Dudley-Evans and St. John (1998) believe that in many cases there is a one-to-one relationship between the terms in English and the learners' first language, and so it will be enough to translate the term into the learners' native language after a brief explanation". [10:268]

When intermediate or advanced students of English learn to read specific texts and remember its terminology, after the topic is explained by ESP teacher with special qualifications in the field of ESP, they will be able to communicate on the given topic much more easily than if the topic was not familiar to them. In this way the teachers qualifications combined with students' level and motivation can result in good communicative skills that are necessary for any specialist in professional practice and so important for seafarers and maritime field in general.

Hutchinson and Waters mention: "ESP is not different in kind from any other form of language teaching, in that it should be based in the first instance on principles of effective and efficient learning. Though the content of learning may vary there is no reason to suppose that the processes of learning should be any different for the ESP learner than for the General English learner. There is, in other words, no such thing as an ESP methodology, merely methodologies that have been applied in ESP classrooms, but could just as well have been used in the learning of any kind of English. (Hutchinson and Waters 1987, p. 18) [8:3]

Although, Hutchinson and Waters say that methodology of ESP does not differ from GE methodology, we think that as ESP teachers are supposed to teach such subjects as technical and scientific texts, its teaching methodology differs from methodology of GE. Specific scientific and technical texts differ in organization, linguistic parameters, grammatical structures used. Good ESP teachers discuss the organization of text with the students. As it was offered by Bhatia: "Teachers are advised to discuss the organization of texts with the students, to highlight the structure of the texts, and demonstrate the language of qualification in legal writing." [8:12]

As it was noted by Araujo Nunes in the article "Teaching English for Specific Purposes: The GUTs to

do it": "In the specific case of English for Science and Technology a proper understanding and appropriate use of discourse is the vital factor". [1:260] Of course EFL teacher can teach discourse better than subject specialist no matter how good his knowledge of English is but the new model of ESP teacher combining knowledge of linguistics with the knowledge of subject would be ideal to deal with the above-mentioned task.

The aim of ESP teaching is to teach students to work with authentic texts i.e. manuals, specific literature, internet resources. ESP teachers work with both adapted and authentic materials. We think that authentic ESP materials should be used in ESP course after certain period of time has passed since the start of ESP course. At the beginning even intermediate and advanced students will find it difficult to deal with authentic specific texts even if they are connected to their specialty and the contents is familiar to them in the native language. One of the objectives of ESP teaching is to enable students to work with Internet resources in this way enriching and keeping up-to-date their professional knowledge. Successful work with authentic texts is the best basis for it.

We think it is quite wise to offer more complicated texts in textbooks than the authentic ones are. In such texts difficult grammar structures are used, the ideas are offered in complicated way. The idea of offering such texts is to teach students to work with maximally difficult texts that are even more difficult than those the students are supposed to work with during their professional lives seems to be realistic and fruitful as it is well-known fact that transition from complicated material to more simple is easier than vice versa.

We think that texts of maritime field can be divided according to registers and would like to refer to our article "Maritime English as part of ESP and as Means of Different Communication Levels" presented at IMLA 20:

"We would like to work out our own classification and divide Maritime English into:

1) Maritime English for Academic Purposes (science, teaching) – MEAP

2) Maritime English for Professional Purposes – MEPP

3) Maritime English for Colloquial Purposes – MECP"(12:)

The documents adopted by IMO and the texts different onshore maritime organizations work with can be allocated to the I type – academic texts. We think that if students are given some extracts from such authentic documents during their studies that would become good basis for them to work with such documents in the future. There are several advantages for such approach: the first one is that working with more difficult text facilitates work with easier text; a lot of seafarers work onshore after they complete their career at sea and if they are prepared to work with documents of academic register their English will be sufficient to work in different maritime organizations where only communication-oriented English is not sufficient and thorough understanding of maritime documents written in complicated English will be required.

Results and Discussion

Prior to transition to the main subject of our work we would like to consider the models of ESP teachers that exist in our country. As it is common in the whole world, generally ESP courses and ME course in particular are taught by English language specialists who acquire the background knowledge of the field they work in. Usually at least two or three years are necessary for language specialist who does not have any specific knowledge to assimilate in the specific field. The other type of ESP teacher is the specialist of the specific field with the knowledge of foreign language but the percentage of occupancy of the former type is much larger than of the latter.

It should be noted here that the above-mentioned is actual generally for our country whereas the situation all over the world can be different. Thus C. Cole, P. Trenkner, B. Pritchard in their article "The Profile of an Integrated Maritime English Lecturer – Status-Quo and Nice-to-have" say: "In the recent years it has become evident that an increasingly large portion of the curriculum in non-native English speaking MET institutions, in some cases 100%, is being taught through English; Piri Reis is a good example of this. The question nonetheless is why should English be the medium of instruction and assessment in preference to that of the local language? And at the core, is this the way ahead?" (6:158) It should be noted that at the above-mentioned University English is taught by professional seafarers who have good command of English and can teach special subjects in English as in the case of Piri Reis University described in the article "The Profile of an Integrated Maritime English Lecturer – Status-Quo and Nice-to-have".

In the present work we intend to consider existing models of ESP/ME teachers and discuss new model of ESP/ME teacher who in our opinion would receive special qualifications to be able to work in such field as Maritime English and we will also offer the variant of the curriculum that could be applied by some maritime higher education institutions to educate future ME lecturers properly. The main objective for our offer is to ensure improving of ESP studies and ME in particular as when ESP teacher is aware of subject matter i.e. has adequate qualifications provided that ESP students have to be intermediate or advanced students of English, and if they know the subject in their native language, the process of studies will not be too difficult as the only thing students will be obliged to do is to remember English terminology, acquire skills in reading the specific texts that will help them to remember the terms better.

The curriculum for preparation of such model of ESP/ME teacher should include not only linguistic subjects but also fundamentals of special maritime subjects the ESP/ME teacher is supposed to work with in the future. The future ESP/ME teachers should work with already developed ESP courses to acquire as much English terminology of maritime fields as possible. Above all, having gained specific fundamental knowledge in different fields and English terminology of the fields, future ESP/ME teachers should work with samples of authentic texts in order to be able to work with authentic texts used in the maritime field in the future and be qualified to teach them to their students.

Our idea is to offer a kind of unified curriculum for ME teachers all over the world, so that ME teachers are educated according to identical program, consequently they will be able to teach their own students according to the common standards and that will result in good knowledge of English by professionals on the global level. We think that this kind of approach would be solution to ME teachers' education problem in the today's globalized world.

In the present article we are considering phenomenon of ESP teacher and try to offer a new model of ESP teacher on example of ME teacher as Maritime English is part of ESP. Although ESP is much broader concept than ME we would like to draw the reader's attention that in the present article we generally focus on such issue as Maritime English thus using term ESP we still refer to ME.

In our opinion, it is not only qualification of ESP teacher that conditions the result of ESP teaching but also the level of preparation of the students as from linguistic as well from professional points of view.

Intermediate and advanced level of GE combined with knowledge of the subject by the students, facilitates ESP studies process and thus the students' motivation to study ESP course will be raised and consequently the results of the studies will be improved. If this problem is solved then ESP teachers will avoid demotivation of the students of ESP that sometimes has crucial effect on the ESP studies and its results. Here we think it is expedient to refer to the words of Dora Chostelidou in the article "A Record of the Training Needs of ESP Practitioners in Vocational Education":

"Also the problem of demotivation was pointed out. The majority of the respondents claimed that students are poorly motivated; perhaps they feel that the study of the language was imposed up to them by the institutions or they may not appreciate the value of their ESP course.

In addition, the students' lack of interest in learning ESP causes a lot of problems in the teaching process, as most of the participants stated that they cannot develop their students' motivation. ESP teachers declared they need to adapt to the multifaceted nature of ESP and find ways to encourage the students' intention to learn and to act as consultants, which involves diagnosing the learners' language and communicative needs". [4:137]

In the present work we decided to establish the correlation of qualifications and experience of ESP teachers and ESP students that is very important in receiving good results.

I. For this purpose we offer the existing models of ESP teachers:

1. ESP teacher – EFL teacher with the experience in ESP/ME
2. Subject teacher with the knowledge of English
3. ESP teacher holding two degrees both in linguistics and subject area
4. ESP/ME teacher with specific ESP qualifications (newly offered model)

II. And the existing models of potential ESP/ME students:

1. Elementary knowledge of GE (A1, A2)
2. Intermediate knowledge of GE (B1, B2)
3. Advanced knowledge of GE (C1, C2)
4. Elementary knowledge of GE (A1, A2) with knowledge of specific subject
5. Intermediate knowledge of GE (B1, B2) with knowledge of specific subject
6. Advanced knowledge of GE (C1, C2) with knowledge of specific subject

In our opinion the most efficient cooperation between ESP teachers and ESP students will be:

1/I ESP teacher – EFL teacher with the experience in ESP – 2,3/II Intermediate knowledge of GE (B1, B2), Advanced knowledge of GE (C1, C2)

2/I Subject teacher with the knowledge of English –2,3/II Intermediate knowledge of GE (B1, B2), Advanced knowledge of GE (C1, C2)

4/I ESP teacher with specific ESP qualifications (newly offered model) – 2,3/II Intermediate knowledge of GE (B1, B2), Advanced knowledge of GE (C1, C2)

The ideal combination of teacher – student cooperation is: 4/I ESP teacher with specific ESP qualifications (newly offered model) – 2,3/II Intermediate knowledge of GE (B1, B2), Advanced knowledge of GE (C1, C2)

But in reality most often we have to deal with the following combination of ESP teacher-student cooperation model: 1/I ESP teacher – EFL teacher with the experience in ESP/ME - 1,2/II Elementary knowledge of GE (A1, A2), Intermediate knowledge of GE (B1, B2)

The combination 2/I Subject teacher with the knowledge of English (the sample discussed above on the example of Piri Reis University) -3/II Advanced knowledge of GE (C1, C2) is seldom for Georgia.

In our opinion the 3rd model of ESP teacher - ESP teacher holding two degrees both in linguistics and subject area, in our case it is GE teacher who would be qualified in Maritime field i.e. has fundamental knowledge of general maritime subjects is ideal for teaching ESP/ME but there are not very many ESP/ME teachers with such qualifications in the whole world and if such teacher teaches the model of the student 5,6/II (Intermediate knowledge of GE (B1, B2) with knowledge of specific subject, Advanced knowledge of GE (C1, C2) with knowledge of specific subject) the best possible results in acquiring ESP for particular field are guaranteed.

The students' models 4,5,6/II (Elementary knowledge of GE (A1, A2) with knowledge of specific subject, Intermediate knowledge of GE (B1, B2) with knowledge of specific subject, Advanced knowledge of GE (C1, C2) with knowledge of specific subject are very rare in Georgia.

The importance of knowledge of General English by students to take ESP course can be supported by following words of Kaosar M. in the article "The ESP Teacher: Issues, Tasks and Challenges": "Through training, ESP teachers are provided with the necessary knowledge and tools to deal with their own students' specializations. Bojović (2006) reminds that ESP teachers are not specialists in the field, but in teaching English, their subject is English for the profession but

not the profession in English. They help students, who know their subject better than the teachers do, develop the essential skills in understanding, using, and/or presenting authentic information in their profession. A professional ESP teacher must be able to switch from one professional field to another without being obliged to spend months on getting started" [8:18].

In our opinion, the minimum level to acquire ESP is B1 (intermediate), otherwise work with authentic materials would be very difficult even after two years of ESP studies.

In the models of students singled out in this work (4,5,6/II) we mentioned such quality as subject knowledge and the students with such knowledge are ideal for mastering ESP but reality shows that students' models 1,2,3/II - Elementary knowledge of GE (A1, A2), Intermediate knowledge of GE (B1, B2), Advanced knowledge of GE (C1, C2) are much more common in Georgia and other countries and frequently the issue of simultaneous study of topics in native and English language is very acute. Of course, we fully agree with the idea expressed by Blagojević S. in the article: "Original Texts as Authentic ESP Teaching Material – the Case of Philosophy" when he says that: "In order to enable students of philosophy to understand philosophy texts in English, it is essential that course book texts should comply with the content of other subjects of the curriculum". [3:121] Nevertheless, still we think that if ESP teacher - ESP student combination 4/I (ESP teacher with specific ESP qualifications (newly offered model) - 3/II (Advanced knowledge of GE (C1, C2)) is applied, the cooperation and result could be successful even if the texts in English are rendered earlier than texts on the same topic in the native language.

There are many reasons why we think that it is necessary to give specific qualifications to ESP/ME teachers. We are sure if ESP/ME teacher receives appropriate qualifications before starting the work i.e. is educated according to the model of the curriculum offered in the present article and not during working process when gaining the practica experience as it usually happens, such teacher will be able to render content information more professionally to the students than EFL teachers. In this way ME lecturers would receive adequate qualifications to perform their duties in maximally effective way. We think it is expedient to support this idea by the words of John Swales: "All researches interested in assessing the progress of ESP as a component of ELT agree that one of the most constraining factors to this progress is the lack of "specialized teacher-training" (Swales1985: 214) [9:450]

Conclusion

If the model of Maritime teacher developed in the present article is applied in practice and some Maritime University offers Master's Degree program for EFL teachers to be qualified as ME teachers it could become the serious step in improving the quality of ME teacher training courses in the future. This opinion can be supported by the fact that thorough understanding of the essence of the courses delivered by teachers themselves, the knowledge of terminology on professional level will change the quality of the lectures delivered and will help students to raise motivation during ESP studies that will result in the improved knowledge of English by professionals of different fields.

In order to implement this idea, the curriculum should be worked thoroughly on basis of collaboration between specialists of linguistics and Maritime field who are supposed to offer fundamentals of their disciplines for ME teachers' curriculum in the scope necessary to receive basic knowledge about the subjects and terminology in English to be able to work with similar authentic materials in English with ME students in future. If such curriculum is worked out, it can become unified basis for producing Maritime English specialists for different maritime educational institutions all over the world that will help in establishing one common standard for ME teacher training.

Abbreviations

GE – General English
EFL – English as a Foreign Language
ESP – English for Specific Purposes
ME- Maritime English

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INTEGRATING CRITICAL THINKING INTO PUBLIC SPEAKING TRAINING FOR FUTURE DIPLOMATS AND IR SPECIALISTS

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Abstract

The industry of international relations is one of the most influential sectors of a country's economic development. Therefore, the training of qualified students in the field of international relations requires special attention to the development of public speaking skills. One of the most effective approaches to forming these skills is the use of critical thinking methods.

The study involved two groups of 18-year students in the educational program "International Relations". Group A was the experimental group, and Group B was the control group. In the experimental group, critical thinking techniques (brainstorming, KWL table, RAFT, "ladder of values", "thin and thick questions") were integrated into the learning process.

The results of the pre-test and post-test showed a significant improvement in public speaking skills, confidence in communication, and the ability to make logical and effective decisions in the experimental group compared to the control group. The application of critical thinking methods had a positive impact on the development of communicative competencies among students of the "International Relations" profile.

Keywords: international relations, public speaking skills, critical thinking, communicative competence, teaching methods.

Introduction

Public speaking is a core competency for International Relations (IR) students. Future diplomats, policy analysts, negotiators, and analysts must articulate complex global issues persuasively, defend positions under scrutiny, and engage diverse audiences. Critical thinking (CT) — the ability to analyze information, evaluate evidence, identify biases, construct logical arguments, anticipate counterarguments, and challenge assumptions — directly enhances these skills by transforming speeches from mere delivery into reasoned, evidence-based persuasion. Research shows that integrating CT methods significantly improves speaking ability, organization of ideas, confidence, and overall performance, particularly in higher education and fields like IR where argumentation and diplomacy are central.

The industry of international relations is one of the most influential sectors of economic development in any country worldwide. Through international relations, countries can compete with each other by attracting foreign guests. In addition, this sector creates opportunities to showcase the country's attractions and culture on the global stage.

Currently, many companies operate in the field of international relations, which intensifies competition. During trips, companies organize various activities to meet the needs of guests. To increase interest in their services, they offer promotions, transportation services, accommodation, leisure activities, security, and enhanced customer trust. The increase in the number of guests traveling through a company depends directly on the professionalism of each employee.

International relations are organized for different purposes and include several types: business, volunteer, ecological, medical, experimental, and religious. All these types have a significant impact on the economies of countries and contribute to their emergence as leading states. A special place belongs to cultural international relations, which involve familiarization with the culture, lifestyle, cuisine, and traditions of a country.

The East Kazakhstan Region remains one of the leading regions for the development of international relations in Kazakhstan. The number of domestic guests in the region significantly exceeds the number of foreign visitors.

In this regard, the specialty "International Relations" is one of the most important professions in any country. The quality of education for students in this profile directly affects the development of the industry and the country's access to the global level.

The formation of public speaking skills among students of the "International Relations" profile helps them achieve career success. It is important to speak correctly and confidently, build good relationships with guests, and receive positive feedback. A special place is occupied by the English language as the most suitable means of communication with foreign guests. Public speaking skills in English are an important component of specialist training.

The aim of the study is to determine the influence of critical thinking methods on the development of public speaking skills among students of the "International Relations" profile.

Methods and Methodology of the Research One of the main components of success in the field of international relations is the formation of communicative competence, as the industry involves constant interaction with a large number of people.

Critical thinking is the ability to analyze, formulate, evaluate, and reflect on acquired experience. The main critical thinking techniques used in the study were:

- **Brainstorming** — free generation of ideas for solving problems that arise during international trips;
- **Ladder of Values** — comparison of the complexity of situations and prioritization when communicating with guests;
- **KWL Table** (Know — Want to know — Learned) — structuring and expanding knowledge about destinations and objects of international relations;
- **Thin and Thick Questions** — development of the ability to answer questions of varying complexity;
- **RAFT** (Role — Audience — Format — Topic) — a role-playing game that allows students to assume different professional roles and develop public speaking skills.

Experimental Work

The study involved two groups of 3rd-year students in the educational program "International Relations": experimental (Group A) and control (Group B).

In the experimental group (A), critical thinking techniques were integrated into the learning process. At each lesson, students were given assignments related to their specialty. In the control group (B), classes were conducted according to the standard program without the use of these techniques.

To assess effectiveness, a pre-test and post-test were conducted, consisting of 15 questions that modeled real situations in the field of international relations.

Results of the Study and Their Discussion

According to the pre-test results, no significant difference was observed between the groups.

After the implementation of critical thinking techniques in the experimental group (A), students showed noticeable improvement in public speaking skills. They learned to speak more freely in front of an audience, confidently answer any questions from guests, and make logical decisions in emerging problems.

In the control group (B), the development of skills occurred slowly, and no significant dynamics were identified between the pre-test and post-test.

The obtained data confirm the effectiveness of using critical thinking methods for the formation of professionally significant competencies.

Why Critical Thinking Matters in Diplomacy

Diplomacy involves negotiation, representation, conflict prevention, and relationship-building. Critical thinking equips diplomats to:

- **Analyze complex situations** — Distinguish facts from assumptions, identify root causes, and understand cultural/political contexts.
- **Anticipate outcomes** — Evaluate risks, benefits, and long-term implications of actions or proposals.
- **Construct persuasive arguments** — Build logical cases while anticipating counterarguments.
- **Adapt flexibly** — Navigate uncertainty, cultural differences, and shifting power dynamics.
- **Make ethical, informed decisions** — Balance national interests with global cooperation and avoid biases.

Without it, diplomats risk miscommunication, escalation of conflicts, or missed opportunities for cooperation. In your article's context (students of the "International Relations" profile), developing these skills through targeted techniques directly prepares them for real diplomatic roles, such as handling guest interactions, crisis management, or public representation — much like the public speaking focus in study.

Use these CT-driven methods, proven to boost public speaking performance:

Table 1:

Method	Description & IR Application	How CT Is Integrated	Expected Outcomes	Evidence/Support
Flipped Classroom	Students watch short videos/readings on IR topics at home; class time focuses on practice and feedback.	Pre-class CT questions (e.g., "What assumptions underlie this policy?"). In-class: argumentative speeches with peer critique.	Higher post-test scores in organization, persuasion, and delivery across all CT levels.	Significant improvement vs. traditional lectures.
Structured Debates & Model UN Simulations	Teams debate IR topics (e.g., "Should NATO expand?" or climate treaty negotiations).	Research evidence, construct pro/con arguments, rebuttals using CT frameworks (e.g., systems thinking).	Strong argumentation, quick thinking, audience adaptation.	Common in IR programs; builds diplomacy + speaking.
Formal Briefing & TED-Style Presentations	Deliver policy briefs or "TED Talks" on IR issues (e.g., digital diplomacy or sanctions).	Use structured analytic techniques (e.g., red-team analysis for alternative viewpoints).	Clear structure, visual aids, persuasive narrative.	Used in top IR schools (e.g., Elliott School at GWU).
Speech Analysis & Genre Reading	Critique sample speeches; rewrite/re-deliver them with improvements.	Apply CT rubrics: clarity, evidence, counter-arguments, audience resonance.	Better organization and self-reflection.	Proven in university public speaking courses.
Socratic Seminars & Case Studies	Discuss real IR cases (e.g., Cuban Missile Crisis) in roundtable format, then present conclusions.	Question assumptions, explore alternatives, evaluate evidence collaboratively.	Confidence in spontaneous speaking + logical flow.	Core to IR critical thinking courses

Key Applications of Critical Thinking in Diplomacy

1. **Negotiation and Bargaining** Diplomats must understand their own interests deeply while appreciating the other side's perspectives, fears, and incentives. Critical thinking helps reshape perceptions so the other party sees an agreement as mutually beneficial. It involves weighing trade-offs, identifying alternatives (BATNA — Best Alternative to a Negotiated Agreement), and avoiding emotional or positional traps.
2. **Strategic Foresight and Policy Analysis** In a multipolar world with "wicked problems" (e.g., climate change, cyber threats, or regional conflicts), diplomats use critical thinking for long-term planning. This includes scenario analysis, evaluating geopolitical trends, and crafting policies that maximize flexibility in complex systems.
3. **Communication and Persuasion** Clear, logical, and tactful communication is vital. Critical thinking enables diplomats to organize messages, anticipate reactions, use evidence effectively, and practice active listening. It supports drafting policy briefs, delivering speeches, or engaging in public diplomacy without causing misunderstandings.
4. **Cross-Cultural Understanding and Empathy** Diplomats must interpret nonverbal cues, challenge cultural biases, and build trust. Critical thinking promotes empathy while maintaining objectivity — questioning one's own assumptions about other cultures.
5. **Crisis Management and Conflict Prevention** In high-stakes situations, rapid yet reasoned analysis prevents escalation. Techniques like evaluating evidence in real time or considering multiple viewpoints help de-escalate tensions.

Conclusion

How Critical Thinking Techniques Apply to Diplomacy

The techniques from your article transfer directly to diplomatic training:

- **Brainstorming** — Generates creative options during negotiations or crisis response.
- **KWL Table** — Structures preparation before meetings (what we know about the counterpart, what we need to learn).
- **RAFT** — Practices role-playing different perspectives (e.g., as a negotiator addressing foreign audiences).
- **Thin and Thick Questions** — Prepares for Q&A in press conferences or bilateral talks (simple facts vs. deep strategic inquiries).
- **Ladder of Values** — Prioritizes issues in multi-party talks.

Additional techniques particularly useful in diplomacy (building on earlier discussions):

- **Socratic Questioning** — Probes assumptions during negotiations ("What evidence supports this position? What are the implications?").
- **Six Thinking Hats** — Encourages balanced discussion (facts, emotions, risks, benefits, creativity) in team briefings.
- **PMI (Plus-Minus-Interesting)** — Evaluates proposals objectively before committing.

- **Devil's Advocate** — Tests the strength of one's own position by arguing against it.
- **Strategic Diplomacy Frameworks** — Holistic tools for navigating complexity, including mindset shifts toward systems thinking.

Benefits for Students in International Relations Programs

Integrating critical thinking into education (as in your experimental vs. control group design) develops:

- Confidence in public speaking and argumentation.
- Ability to handle real-world scenarios like treaty negotiations or cultural exchanges.
- Long-term career readiness — diplomats need these skills for leadership, coalition-building, and adaptive responses in a changing global landscape.

Training often includes simulations, debates, case studies, and reflective practices. Modern diplomacy also emphasizes digital literacy and strategic communication in virtual or hybrid environments.

In summary, critical thinking transforms diplomacy from reactive protocol into proactive, intelligent statecraft. It enables diplomats to turn potential conflicts into opportunities for cooperation while advancing national interests responsibly.

How These Techniques Work Together in Study

In the experimental group, combining these methods helped students:

- Generate ideas (Brainstorming)
- Analyze and prioritize problems (Ladder of Values)
- Organize knowledge (KWL)
- Handle different question types (Thin & Thick)
- Practice real-life communication (RAFT)

This led to better **public speaking skills** — more confidence, logical structure, quicker thinking on their feet, and the ability to make effective decisions when interacting with guests.

These techniques are widely used in education because they are active, student-centered, and directly support higher-order thinking (analysis, evaluation, creation) rather than just recall.

The conducted experimental study allows us to formulate the following main conclusions:

1. Public speaking skills are one of the key professional competencies of students in the "International Relations" profile, since successful work in this field requires constant effective communication with domestic and foreign guests.

2. The integration of critical thinking methods into the educational process significantly enhances the development of public speaking skills. Students in the experimental group demonstrated a higher level of confidence in speech, logical presentation, and the ability to quickly solve non-standard tasks compared to students in the control group.

3. The use of techniques such as brainstorming, KWL table, RAFT, "ladder of values", and "thin and thick questions" contributes not only to the improvement of speaking skills but also to the comprehensive development of analytical and systemic thinking, which is especially important for future specialists.

4. The results of the study confirm the feasibility and high effectiveness of implementing critical thinking methods in educational programs in the specialty "International Relations".

Based on the obtained data, it is recommended to:

- actively introduce critical thinking techniques into university educational programs;
- develop special methodological materials and practical courses for the development of public speaking skills;
- make wider use of role-playing and situational tasks in the process of student training.

Conclusions (Academic Style) — International Relations

1. **Public Speaking Skills as a Key Competence**

The development of public speaking skills is a fundamental component of professional competence for students specializing in *International Relations*. The effectiveness of activities in diplomacy, international organizations, and analytical or research institutions directly depends on the ability to interact with colleagues, partners, and audiences in an argumentative and persuasive manner.

2. Critical Thinking as the Basis of Communicative Competence

The formation of critical thinking is considered a strategic foundation for developing communicative competence. The ability to analyze international issues, construct logical arguments, and make well-founded decisions enables students to successfully handle professional tasks and non-standard situations in the international arena.

3. Effectiveness of Pedagogical Methods

Integrating critical thinking techniques into the educational process — such as *Brainstorming*, *KWL Table*, *Thin and Thick Questions*, *Ladder of Values*, and *RAFT* — significantly enhances students' professional development. These methods contribute to improving argumentation skills, logical structuring of speech, and confident public speaking within the context of international relations.

5. Evidence from Experimental Data

The results of the experimental study demonstrated statistically significant improvements in the experimental group compared to the control group:

- ✓ increased confidence in public speaking;
- ✓ higher level of knowledge about international processes;
- ✓ improved ability to analyze and solve complex problems.

5.Comprehensive Approach and Systemic Understanding

Applying a comprehensive approach to developing public speaking skills through critical thinking fosters students' systemic understanding of international affairs, stimulates motivation for learning, and contributes to the formation of sustainable professional competencies required for effective functioning in a global environment.

6.Practical Significance of the Study

The integration of modern pedagogical technologies into educational programs in international relations confirms the necessity of continuously improving teaching methods. Such practice prepares competitive specialists capable of adequately responding to global challenges and ensuring a high level of professional competence in dynamic international contexts.

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FORMATION OF ENTREPRENEURIAL SKILLS AMONG SENIOR SCHOOL STUDENTS: INTERNATIONAL EXPERIENCE AND IMPLEMENTATION IN THE CONTEXT OF KAZAKHSTAN

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ЖОҒАРЫ СЫНЫП ОҚУШЫЛАРЫНДА КӘСІПКЕРЛІК ДАҒДЫЛАРДЫ ҚАЛЫПТАСТЫРУ: ХАЛЫҚАРАЛЫҚ ТӘЖІРИБЕ ЖӘНЕ ҚАЗАҚСТАН ЖАҒДАЙЫНДА ЖҮЗЕГЕ АСЫРУ

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Abstract
This article examines the formation of entrepreneurial skills among senior school students. The relevance of the study is determined by the need to develop entrepreneurial thinking in the context of modern economic changes and labor market demands. The paper analyzes international practices and modern methods of entrepreneurship education. The current state in Kazakhstan is considered, and recommendations are proposed.

Аннотация
Мақалада жоғары сынып оқушыларында кәсіпкерлік дағдыларды қалыптастыру мәселелері қарастырылады. Зерттеудің өзектілігі қазіргі қоғамдағы экономикалық өзгерістер мен еңбек нарығының талаптарына байланысты оқушылардың кәсіпкерлік ойлауын дамыту қажеттілігімен негізделеді. Жұмыста кәсіпкерлік білім берудің халықаралық тәжірибелері талданады. Сонымен қатар, мектеп деңгейінде кәсіпкерлік дағдыларды қалыптастырудың заманауи әдістері қарастырылады. Қазақстан мектептеріндегі кәсіпкерлік білім берудің қазіргі жағдайына талдау жасалып, негізгі мәселелер анықталады. Зерттеу нәтижесінде кәсіпкерлік дағдыларды тиімді қалыптастыруға бағытталған ұсыныстар берілді.

Keywords: entrepreneurial skills, high school students, entrepreneurship education, competencies, Kazakhstan
Түйін сөздер: кәсіпкерлік дағдылар, жоғары сынып оқушылары, кәсіпкерлік білім, құзыреттілік, білім беру, Қазақстан

Қазіргі жаһандану жағдайында білім беру жүйесі түбегейлі өзгерістерге ұшырауда. Экономиканың дамуы, цифрландыру және еңбек нарығындағы бәсекелестіктің артуы оқушылардан жаңа дағдыларды талап етеді. Осындай дағдылардың бірі – кәсіпкерлік құзыреттілік.

Кәсіпкерлік дағдылар тұлғаның бастамашылдығын, тәуекелге бару қабілетін, шығармашылық ойлауын және мәселелерді шешу дағдыларын қамтиды [1, 3 б.]. Бұл дағдылар тек бизнес саласында ғана емес, кез келген кәсіби қызметте маңызды болып табылады.

Зерттеудің мақсаты – жоғары сынып оқушыларында кәсіпкерлік дағдыларды қалыптастырудың тиімді жолдарын анықтау және халықаралық тәжірибе негізінде ұсыныстар әзірлеу.

Кәсіпкерлік білім беру мәселесі көптеген халықаралық зерттеулерде қарастырылған. Ғалымдардың пікірінше, кәсіпкерлік құзыреттілік – бұл тұлғаның жаңа идеяларды іске асыру қабілеті [2, 5 б.].

Халықаралық тәжірибеде кәсіпкерлік білім беру келесі бағыттарда жүзеге асырылады:

- практикалық оқыту
- жобалық әдіс
- стартап мәдениеті
- инновациялық ойлау

Зерттеулер көрсеткендей, оқушылар кәсіпкерлік дағдыларды тек теория арқылы емес, тәжірибе арқылы тиімді меңгереді [3, 10 б.].

Зерттеу барысында келесі әдістер қолданылды:

- ғылыми әдебиеттерді талдау
- салыстырмалы әдіс
- жүйелік талдау
- бақылау

Бұл әдістер кәсіпкерлік білім берудің тиімді тәсілдерін анықтауға мүмкіндік берді.

Кәсіпкерлік дағдыларды қалыптастыру – көпқырлы процесс. Ол білім беру мазмұнын, оқыту әдістерін және білім беру ортасын қамтиды.

Қазіргі таңда кәсіпкерлік дағдыларды дамыту келесі әдістер арқылы жүзеге асырылады:

- жобалық оқыту (Project-Based Learning)
- кейс-стади
- бизнес-симуляциялар
- топтық жұмыс

Бұл әдістер оқушылардың белсенділігін арттырып, олардың практикалық тәжірибе алуына мүмкіндік береді [4, 12 б.].

Қазақстанда кәсіпкерлік білім беру біртіндеп енгізіліп келеді. Дегенмен, келесі мәселелер байқалады:

- оқытудың теориялық бағытта болуы
- практикалық жұмыстардың аздығы

- мұғалімдердің дайындық деңгейінің әртүрлілігі

Зерттеу нәтижесінде келесі жағдайлар анықталды:

- кәсіпкерлік дағдылар жүйелі түрде дамытылмайды
- оқушылардың кәсіпкерлік қызығушылығы жоғары
- практикалық тапсырмалар жетіспейді

Сонымен қатар, кәсіпкерлік білім беру тиімді болуы үшін оқыту әдістерін жаңарту қажет екені анықталды. Қазіргі білім беру жүйесінде кәсіпкерлік дағдыларды қалыптастыру тек жеке пән ретінде ғана емес, пәнаралық интеграция арқылы жүзеге асырылуы тиіс. Бұл тәсіл оқушылардың алған білімдерін нақты өмірлік жағдайларда қолдануына мүмкіндік береді. Мысалы, экономика, математика және информатика пәндерін байланыстыра отырып, бизнес-жобалар әзірлеу оқушылардың аналитикалық және стратегиялық ойлау қабілеттерін дамытады [6, 14 б.].

Кәсіпкерлік дағдыларды қалыптастырудың маңызды компоненттерінің бірі – қаржылық сауаттылық. Қаржылық білім оқушыларға жеке бюджет құру, инвестициялау негіздерін түсіну және қаржылық тәуекелдерді бағалау сияқты дағдыларды меңгеруге көмектеседі. Зерттеулер көрсеткендей, қаржылық сауаттылық деңгейі жоғары оқушылар болашақта экономикалық тұрғыдан табысты болады [7, 9 б.].

Сонымен қатар, кәсіпкерлік дағдыларды дамытуда цифрлық технологиялардың рөлі артып келеді. Қазіргі таңда онлайн-платформалар, симуляциялық бағдарламалар және цифрлық құралдар оқыту процесін тиімді ұйымдастыруға мүмкіндік береді. Мысалы, виртуалды бизнес-ойындар оқушыларға нақты нарықтық жағдайларды модельдеуге және шешім қабылдау дағдыларын дамытуға көмектеседі [8, 11 б.].

Кәсіпкерлік білім берудің тағы бір маңызды аспектісі – soft skills дамыту. Оларға коммуникация, көшбасшылық, уақытты басқару және топпен жұмыс істеу дағдылары жатады. Бұл дағдылар кәсіпкерлік қызметтің ажырамас бөлігі болып табылады және оқушылардың жалпы тұлғалық дамуына ықпал етеді [9, 6 б.].

Халықаралық тәжірибеде кәсіпкерлік дағдыларды қалыптастыруда мектеп пен бизнес арасындағы серіктестік маңызды рөл атқарады. Көптеген елдерде кәсіпкерлер мен бизнес өкілдері оқу процесіне қатысып, мастер-класстар өткізіп, оқушыларға практикалық тәжірибе береді. Мұндай тәсіл оқушылардың мотивациясын арттырып, олардың болашақ мамандығын саналы таңдауға ықпал етеді [10, 8 б.].

Қазақстан жағдайында мұндай тәжірибелер енді ғана дамып келеді. Кейбір мектептерде кәсіпкерлік негіздері бойынша факультативтік курстар мен үйірмелер ұйымдастырылған. Алайда олардың қамту деңгейі әлі де төмен және жүйелі сипатқа ие емес [5, 18 б.].

Сондай-ақ, кәсіпкерлік дағдыларды қалыптастыруда оқыту ортасының маңызы зор. Қолайлы білім беру ортасы оқушылардың шығармашылық белсенділігін арттырып, олардың жаңа идеяларды жүзеге асыруына мүмкіндік береді. Бұл ретте мектеп әкімшілігінің қолдауы, мұғалімдердің кәсіби құзыреттілігі және оқу ресурстарының жеткіліктілігі маңызды факторлар болып табылады [6, 20 б.].

Зерттеулер көрсеткендей, кәсіпкерлік дағдыларды тиімді қалыптастыру үшін оқыту процесі оқушыға бағытталған болуы тиіс. Яғни, оқушылардың қызығушылықтары мен қажеттіліктерін ескере отырып, жеке білім беру траекториясын құру маңызды [7, 13 б.].

Бұдан бөлек, кәсіпкерлік білім беруде бағалау жүйесін жетілдіру қажеттілігі туындайды. Қазіргі таңда бағалау көбінесе теориялық білімге негізделеді. Ал кәсіпкерлік дағдыларды бағалау үшін жобалар, портфолио және практикалық тапсырмалар қолданылуы тиіс [8, 16 б.].

Осылайша, кәсіпкерлік дағдыларды қалыптастыру кешенді тәсілді талап етеді. Ол білім беру мазмұнын жаңартуды, оқыту әдістерін жетілдіруді және білім беру ортасын дамытуды қамтиды.

Халықаралық тәжірибемен салыстырғанда, Қазақстанда кәсіпкерлік білім беру әлі де даму кезеңінде. Көптеген елдерде бұл бағыт мектеп бағдарламасының негізгі бөлігі болып табылады.

Зерттеу нәтижелері кәсіпкерлік дағдыларды дамытуда тәжірибелік оқытудың маңыздылығын көрсетті. Сонымен қатар, цифрлық технологияларды енгізу білім беру сапасын арттыруға мүмкіндік береді.

Жоғары сынып оқушыларында кәсіпкерлік дағдыларды қалыптастыру – білім беру жүйесінің маңызды міндеттерінің бірі.

Зерттеу нәтижесінде келесі ұсыныстар жасалды:

- кәсіпкерлік білім беруді оқу бағдарламасына енгізу
- тәжірибелік оқыту әдістерін дамыту
- мұғалімдердің біліктілігін арттыру
- цифрлық құралдарды пайдалану

Бұл шаралар оқушылардың болашақта табысты болуына ықпал етеді.

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FORMS AND METHODS OF MANAGING THE EDUCATIONAL PROCESS IN MODERN SCHOOLS BASED ON DIGITAL MONITORING

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ФОРМЫ И МЕТОДЫ УПРАВЛЕНИЯ ОБРАЗОВАТЕЛЬНЫМ ПРОЦЕССОМ В СОВРЕМЕННОЙ ШКОЛЕ НА ОСНОВЕ ЦИФРОВОГО МОНИТОРИНГА

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Abstract

The article explores modern forms and methods of managing the educational process in schools in the context of digitalization. Administrative, socio-psychological, information-analytical, and control-regulatory methods and their integrated application are analyzed. The author's model of management based on digital monitoring is presented, including target, content, analytical, managerial, and corrective components. The practical significance of the model lies in improving the quality of education and the effectiveness of school management.

Аннотация

Статья посвящена современным формам и методам управления образовательным процессом в школе в условиях цифровизации. Рассмотрены организационно-распорядительные, социально-психологические, информационно-аналитические и контрольно-регулирующие методы, их комплексное применение и трансформация под влиянием цифровых технологий. Представлена авторская модель управления на основе цифрового мониторинга, включающая целевой, содержательный, аналитический, управленческий и корректирующий компоненты. Практическая значимость модели проявляется в повышении качества образования и эффективности управленческой деятельности.

Keywords: educational process management, digital monitoring, management methods, information-analytical tools, school digitalization

Ключевые слова: управление образовательным процессом, цифровой мониторинг, методы управления, информационно-аналитические инструменты, цифровизация образования

Введение

Современное развитие системы образования Республики Казахстан характеризуется усилением требований к качеству образовательных результатов, модернизацией содержания обучения и активным внедрением цифровых технологий в образовательную и управленческую практику. В этих условиях управление образовательным процессом приобретает ключевое значение, поскольку обеспечивает согласование целей, содержания и результатов обучения, а также устойчивое функционирование и развитие образовательной организации.

Управление образовательным процессом выходит за рамки традиционного административного регулирования и рассматривается как комплексная деятельность, включающая организационные, аналитические и корректирующие механизмы. Это обусловлено усложнением образовательной среды и необходимостью принятия обоснованных управленческих решений на основе объективной информации.

Актуальность исследования определяется противоречием между возрастающими требованиями к эффективности управления образовательным про-

цессом и недостаточной разработанностью моделей управления, основанных на использовании цифрового мониторинга. В условиях цифровизации образования возникает необходимость переосмысления форм и методов управления и их адаптации к современным условиям функционирования образовательных организаций.

Цель статьи заключается в теоретическом обосновании форм и методов управления образовательным процессом в современной школе и выявлении возможностей их совершенствования на основе цифрового мониторинга.

Теоретические основы управления образовательным процессом

В педагогической науке управление рассматривается как целенаправленное воздействие субъекта на объект управления, обеспечивающее его функционирование и развитие в соответствии с заданными целями. В контексте образовательной деятельности управление образовательным процессом представляет собой системно организованную деятельность, направленную на планирование, организацию, координацию, контроль и анализ образовательной деятельности с целью обеспечения качества образования и достижения планируемых результатов обучения.

Существенной характеристикой управления образовательным процессом является его циклический характер, проявляющийся в последовательной реализации взаимосвязанных управленческих функций. Планирование связано с определением целей и прогнозированием результатов, организация — с созданием условий их достижения, координация — с согласованием действий участников образовательного процесса, контроль — с оценкой результатов, а анализ — с выявлением причин отклонений и определением направлений коррекции.

В современных условиях особое значение приобретает аналитическая составляющая управления, связанная с обработкой и интерпретацией информации о состоянии образовательного процесса. Это обусловлено необходимостью повышения обоснованности управленческих решений и перехода к управлению на основе данных.

Управление образовательным процессом носит многоуровневый характер и осуществляется на уровне образовательной организации, структурных подразделений и педагогического взаимодействия. Эффективность управления определяется согласованностью управленческих воздействий и их направленностью на достижение образовательных целей.

Таким образом, управление образовательным процессом в современной школе представляет собой сложную систему, эффективность которой определяется интеграцией управленческих функций и использованием современных информационно-аналитических инструментов.

Формы и методы управления образовательным процессом в современной школе

Формы управления образовательным процессом представляют собой организационные способы реализации управленческой деятельности, определяющие характер взаимодействия субъектов управления, распределение управленческих функций и механизмов принятия решений. В современной школе формы управления выступают не только как инструменты организации управленческой деятельности, но и как важный фактор повышения ее эффективности, обеспечивающий включенность педагогического коллектива в процессы планирования, анализа и развития образовательной деятельности.

Анализ теории и практики внутришкольного управления позволяет утверждать, что в современной образовательной организации используется совокупность взаимодополняющих форм управления, различающихся по степени централизации, характеру взаимодействия субъектов и функциональной направленности. Традиционно выделяются административные формы управления, основанные на иерархической структуре и предполагающие реализацию управленческих решений через систему приказов, распоряжений и нормативных документов. Данные формы обеспечивают стабильность функционирования образовательной организации, нормативную упорядоченность образовательного процесса и соблюдение установленных требований, однако их эффективность в современных условиях существенно возрастает при сочетании с более гибкими и демократичными формами управления.

К числу таких форм относятся коллегиальные формы управления, предполагающие участие педагогического коллектива в обсуждении и принятии управленческих решений. Коллегиальные формы реализуются через деятельность педагогических советов, методических объединений, рабочих групп и иных профессиональных сообществ, функционирующих в образовательной организации. Их значимость обусловлена тем, что они способствуют развитию профессионального взаимодействия, формированию единого образовательного пространства и повышению ответственности педагогов за результаты образовательной деятельности.

В современных условиях особую роль приобретают командные формы управления, ориентированные на совместную деятельность педагогов в рамках решения конкретных образовательных задач. Командный подход позволяет обеспечить гибкость управления, оперативность реагирования на изменения образовательной среды и эффективное распределение ответственности между участниками образовательного процесса. Он тесно связан с развитием проектных форм управления, которые реализуются через временные творческие группы, направленные на разработку и внедрение инновационных образовательных практик.

Следует отметить, что в условиях цифровизации образования происходит трансформация традиционных форм управления, связанная с внедре-

нием цифровых технологий в управленческую деятельность. Это проявляется в развитии информационно-аналитических форм управления, основанных на использовании цифровых платформ, электронных журналов, систем мониторинга и аналитических инструментов. Указанные формы позволяют обеспечить оперативный доступ к информации о состоянии образовательного процесса, повысить прозрачность управленческой деятельности и создать условия для принятия обоснованных управленческих решений.

Наряду с этим сохраняют свою значимость контрольно-диагностические формы управления, направленные на оценку качества образовательного процесса и выявление отклонений от планируемых результатов. Однако в современных условиях данные формы также претерпевают изменения, переходя от формального контроля к диагностике и аналитической оценке образовательных результатов, что позволяет использовать полученные данные для совершенствования образовательной деятельности.

Таким образом, формы управления образовательным процессом в современной школе характеризуются разнообразием и взаимодополняемостью, а их эффективность определяется способностью образовательной организации обеспечить их рациональное сочетание с учетом целей, задач и условий функционирования.

Методы управления образовательным процессом

Методы управления образовательным процессом представляют собой совокупность способов и приемов целенаправленного воздействия на участников образовательной деятельности и условия ее реализации, обеспечивающих достижение поставленных целей и задач. В отличие от форм управления, определяющих организационную структуру управленческой деятельности, методы управления отражают ее содержательную сторону и характеризуют механизмы реализации управленческих воздействий.

В педагогической и управленческой науке существует множество подходов к классификации методов управления, однако наиболее распространенным является их разделение на несколько основных групп в зависимости от характера воздействия и используемых механизмов. К числу таких групп относятся организационно-распорядительные, социально-психологические, информационно-аналитические и контрольно-регулирующие методы управления.

Организационно-распорядительные методы направлены на обеспечение нормативной определенности и регламентации образовательного процесса. Они реализуются через систему приказов, распоряжений, инструкций и иных управленческих документов, устанавливающих правила и требования к организации образовательной деятельности. Данные методы обеспечивают дисциплину и управляемость образовательного процесса, однако их эффективность в значительной степени зависит от их обоснованности и согласованности с другими методами управления.

Социально-психологические методы управления ориентированы на воздействие на мотивационную сферу участников образовательного процесса, формирование благоприятного психологического климата и развитие профессионального взаимодействия. Они включают такие механизмы, как убеждение, стимулирование, поддержка, признание профессиональных достижений и создание условий для самореализации педагогов. В современных условиях значение данных методов существенно возрастает, поскольку эффективность образовательного процесса во многом определяется уровнем мотивации и вовлеченности педагогического коллектива.

Информационно-аналитические методы управления связаны со сбором, обработкой, анализом и интерпретацией информации о состоянии образовательного процесса. Их развитие обусловлено цифровизацией образования и внедрением информационных систем, позволяющих аккумулировать значительные объемы данных и использовать их для принятия управленческих решений. Указанные методы обеспечивают объективность управления, позволяют выявлять закономерности и тенденции развития образовательного процесса, а также прогнозировать результаты образовательной деятельности.

Контрольно-регулирующие методы направлены на обеспечение обратной связи в системе управления и коррекцию образовательного процесса. Они включают различные виды контроля, диагностики, мониторинга и анализа результатов образовательной деятельности. В современных условиях данные методы трансформируются, переходя от формального контроля к аналитическому сопровождению образовательного процесса, что позволяет использовать результаты контроля не только для фиксации отклонений, но и для их предупреждения и устранения.

Особое место в системе методов управления образовательным процессом занимают педагогически-развивающие методы, направленные на повышение качества преподавания и профессиональное развитие педагогов. Они реализуются через организацию методической работы, повышение квалификации, наставничество, обмен опытом и внедрение инновационных педагогических технологий. Данные методы обеспечивают развитие кадрового потенциала образовательной организации и выступают важным условием повышения качества образовательного процесса.

Следует подчеркнуть, что в современной школе эффективность управления образовательным процессом определяется не использованием отдельных методов, а их комплексным и взаимосвязанным применением. Это обусловлено многокомпонентностью образовательной среды, разнообразием задач управления и необходимостью учета различных факторов, влияющих на образовательный процесс. Комплексный характер применения методов управления позволяет обеспечить их взаимное усиление и повысить результативность управленческой деятельности.

Таким образом, методы управления образовательным процессом в современной школе представляют собой многоуровневую систему воздействий, обеспечивающую реализацию управленческих функций и достижение образовательных целей. Их развитие в условиях цифровизации образования связано с усилением роли информационно-аналитических методов и интеграцией цифровых инструментов в управленческую практику.

Цифровой мониторинг как инструмент управления образовательным процессом

Современный этап цифровой трансформации образования обусловливает качественные изменения в системе управления образовательным процессом, связанные с расширением возможностей получения, обработки и использования информации. В этих условиях особую значимость приобретает цифровой мониторинг как инструмент информационно-аналитического обеспечения управленческой деятельности, позволяющий обеспечить переход от интуитивного и административного управления к управлению на основе объективных данных.

Цифровой мониторинг в образовательной организации представляет собой систематически организованный процесс сбора, обработки, анализа и интерпретации информации о состоянии и динамике образовательного процесса с использованием цифровых технологий. В отличие от традиционных форм контроля, цифровой мониторинг носит непрерывный, комплексный и аналитически ориентированный характер, что позволяет не только фиксировать результаты образовательной деятельности, но и выявлять закономерности, тенденции и причинно-следственные связи, лежащие в основе образовательных процессов.

Функциональное назначение цифрового мониторинга заключается в обеспечении управленческой деятельности достоверной и актуальной информацией, необходимой для принятия обоснованных решений. В этом контексте цифровой мониторинг выполняет ряд взаимосвязанных функций, включая диагностическую, аналитическую, прогностическую и корректирующую. Диагностическая функция направлена на выявление текущего состояния образовательного процесса, аналитическая — на интерпретацию полученных данных и выявление факторов, влияющих на образовательные результаты, прогностическая — на определение возможных сценариев развития образовательной ситуации, а корректирующая — на разработку и реализацию мер по совершенствованию образовательной деятельности.

Важной характеристикой цифрового мониторинга является его системность, проявляющаяся в охвате различных аспектов образовательного процесса, включая результаты обучения, динамику успеваемости, уровень сформированности компетенций обучающихся, особенности педагогической деятельности и условия реализации образовательных программ. Использование цифровых инструментов позволяет интегрировать данные из различных источников, обеспечивая целостное представление о состоянии образовательной системы.

Внедрение цифрового мониторинга в практику внутришкольного управления способствует повышению объективности управленческих решений, поскольку они основываются на анализе реальных данных, а не на субъективных оценках. Кроме того, цифровой мониторинг обеспечивает оперативность получения информации, что позволяет своевременно выявлять отклонения в образовательном процессе и принимать корректирующие меры. Существенным преимуществом является также возможность прогнозирования образовательных результатов на основе анализа динамики показателей, что позволяет переходить от реактивного к проактивному управлению.

Таким образом, цифровой мониторинг выступает ключевым элементом современной системы управления образовательным процессом, обеспечивая ее аналитическую обоснованность, гибкость и результативность. Его интеграция в управленческую практику создает предпосылки для повышения качества образования и устойчивого развития образовательной организации.

Авторская модель управления образовательным процессом на основе цифрового мониторинга

В условиях цифровизации образования особую значимость приобретает разработка и внедрение моделей управления образовательным процессом, обеспечивающих интеграцию цифровых инструментов в структуру управленческой деятельности. В рамках проведенного исследования предложена авторская модель управления образовательным процессом, основанная на использовании цифрового мониторинга как ключевого элемента информационно-аналитического обеспечения управления.

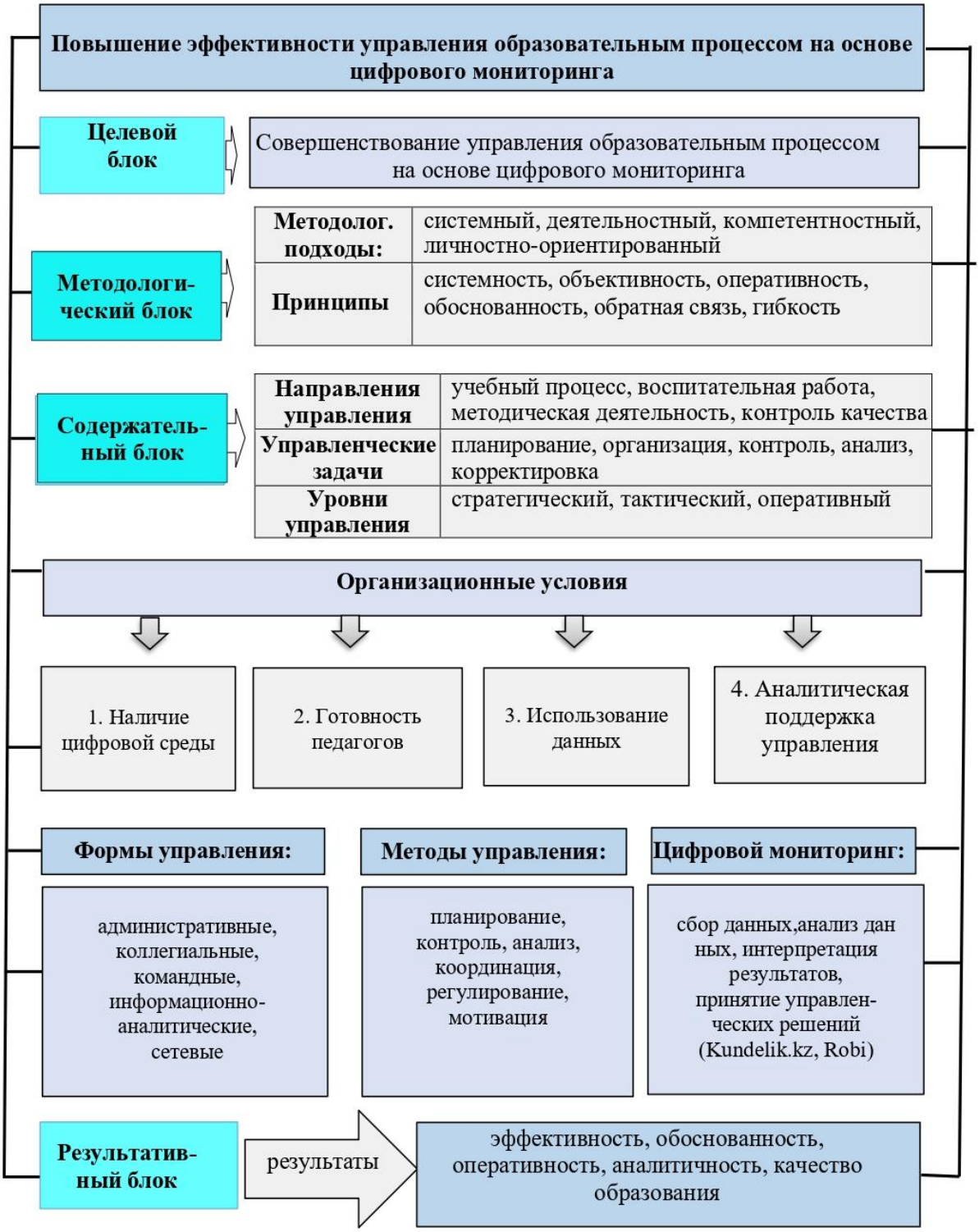

Рисунок 1. Авторская модель управления образовательным процессом на основе цифрового мониторинга

Разработанная модель представляет собой целостную систему, включающую взаимосвязанные структурные компоненты, обеспечивающие реализацию управленческого цикла. В ее структуре выделяются целевой, содержательный, аналитический, управленческий и корректирующий компоненты, каждый из которых выполняет определенные функции в системе управления образовательным процессом.

Целевой компонент определяет стратегические ориентиры управления образовательным процессом, формулирует цели и задачи, направленные на повышение качества образования и достижение планируемых образовательных результатов. Содержательный компонент отражает организацию образовательного процесса, включая планирование учебной деятельности, распределение ресурсов и определение условий реализации образовательных программ.

Аналитический компонент является ключевым элементом модели и обеспечивает сбор, обработку и анализ данных о состоянии образовательного процесса на основе цифрового мониторинга. Его

функционирование направлено на получение объективной информации, необходимой для оценки эффективности образовательной деятельности и выявления проблемных зон.

Управленческий компонент связан с принятием решений на основе результатов анализа данных и включает разработку управленческих воздействий, направленных на совершенствование образовательного процесса. В свою очередь, корректирующий компонент обеспечивает реализацию принятых решений и внесение изменений в образовательную деятельность с учетом выявленных отклонений и тенденций.

Принципиальной особенностью предложенной модели является интеграция цифрового мониторинга во все этапы управленческого цикла, что обеспечивает непрерывность аналитического сопровождения управления и повышает обоснованность управленческих решений. Модель ориентирована на использование данных как основного ресурса управления, что позволяет повысить его эффективность, обеспечить гибкость и адаптивность управленческой деятельности, а также создать условия для устойчивого развития образовательной организации.

Практическая значимость модели заключается в возможности ее применения в деятельности современных школ для совершенствования управления образовательным процессом. Ее внедрение способствует повышению качества образовательных результатов, развитию профессиональной деятельности педагогов и формированию эффективной системы внутришкольного управления, ориентированной на достижение конкретных образовательных целей.

Заключение

Проведенное исследование позволило установить, что управление образовательным процессом в современной школе представляет собой сложную, многоуровневую и динамичную систему, эффективность которой определяется способностью интегрировать различные формы и методы управленческой деятельности. Установлено, что в условиях цифровизации образования происходит трансформация традиционных подходов к управлению, связанная с усилением роли информационно-аналитических механизмов и переходом к управлению на основе данных.

Анализ форм и методов управления образовательным процессом показал, что их эффективность обеспечивается комплексным и взаимосвязанным применением, позволяющим учитывать особенности образовательной среды и обеспечивать достижение образовательных целей. Особое значение в современных условиях приобретает цифровой мониторинг, выступающий ключевым инструментом информационно-аналитического обеспечения управления образовательным процессом.

Разработанная авторская модель управления образовательным процессом на основе цифрового мониторинга обеспечивает интеграцию аналитических инструментов в управленческую деятельность и способствует повышению ее эффективности. Ее использование позволяет обеспечить объективность и обоснованность управленческих решений, повысить качество образовательного процесса и создать условия для устойчивого развития образовательной организации.

Таким образом, результаты исследования подтверждают целесообразность использования цифрового мониторинга в системе управления образовательным процессом и открывают перспективы для дальнейших исследований в области цифровой трансформации внутришкольного управления.

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THE NEGATİVE IMPACT OF A DYSFUNCTİONAL FAMİLY ON ADOLESCENCE: CAUSES OF THE EMERGENCE OF DEVİANT BEHAVİOUR

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UĞURSUZ AİLƏNİN YENİYETMƏYƏ MƏNFİ TƏSİRİ DEVİANT DAVRANIŞININ MEYDANAGƏLMƏ SƏBƏBLƏRİ

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Abstract

Based on research and observations, psychologists and educators have concluded that children are capable of managing their parents. This hidden control is called manipulation. As it is often said: "A child is the best diplomat." A child who can identify their parents' "weak spot" uses it to achieve their own hidden goals.

For example, when a father refuses to buy another doll, a girl might respond: "I love my grandmother the most, she buys me everything." If a boy is forbidden to play the drums early on a Saturday morning, he may stand outside his parents' bedroom and cry loudly until he is allowed to play. As soon as permission is granted, the tears disappear and the game continues.

In such situations, parents initially try to calm the child and stop the tantrum. However, once the child gets what they want, the tears vanish completely. Over time, as children gain experience, they increasingly use their parents' "weak points" to achieve their goals. Children quickly learn which adults can be influenced by tears, shouting, aggression, or flattery. The more promptly parents respond to such behavior, the more often children resort to these methods.

Several types of manipulative behavior in children can be distinguished. The "little dictator" displays stubbornness and often reacts with anger toward others, using tantrums to force adults to meet their demands. The "weak child" does everything possible to make adults do tasks on their behalf.

In fact, children are not born "difficult" or "easy." They are ordinary children who may later become "difficult."

Xülasə

Psixoloq və pedaqoqlar tədqiqat və müşahidələri əsasında belə qənaətə gəliblər ki, uşaqlar öz valideynlərini idarə etməyi bacarırlar. Bu gizli idarəetməyə manipulyasiya deyilir. Oxuyuruq: "Uşaq ən yaxşı diplomatdır. Valideynlərinin "zəif damarı"nı tuta bilən uşaq bundan öz gizli məqsədlərinə çatmaq üçün istifadə edir. Məsələn, qız atanın növbəti gəlinciyi almaq istəməməsinə cavab olaraq "Nənəmi hamıdan çox istəyirəm, o, mənə hər şey alır" deyir. Şənbə günü səhər tezdən oğlana barabanda çalmağı qadağan edirlər, oğlan valideynlərinin yataq otağı qarşısında durub bərkdən ağlayır, o vaxta qədər ki, ona oynamağa icazə verilir. İcazə alınan kimi göz yaşları yoxa çıxır və oyun davam etdirilir. Belə situasiyalarda ilkin olaraq valideynlər uşağı sakitləşdirmək və isterikanı kəsmək istəyirlər. Lakin uşaq istədiyini alan kimi göz yaşından əsər-əlamət qalmır. Zaman keçdikcə, təcrübə qazandıqca uşaq məqsədinə nail olmaq üçün valideynlərinin "zəif damar"ından daha geniş istifadə edir. Uşaqlar yaxşı bilirlər ki, böyüklərdən kimə göz yaşı, qışqırıq və aqressiya, kimə yaltaqlıqla təsir göstərmək olar. Uşaqların bu cür davranışına valideynləri nə qədər çevik reaksiya verərlərsə, uşaqlar bu üsullardan daha çox istifadə edirlər. Uşaq manipulyasiyalarının bir neçə növünü ayırırlar. "Kiçik diktator" inadkarlıq göstərərək ətrafdakılara hər zaman qəzəblə yanaşır. İsterika çıxararaq böyüklərin onun tələbini ödəməyə məcbur edir. "Zəif körpə" böyüklərin onun əvəzinə işləməsi üçün hər şey edir". Əslində uşaqlar "çətin" və "asan" olaraq doğulmurlar. Bu normal uşaqlar sonradan "çətin" olurlar.

Keywords: parents, communication, manipulation, teenager, re-parenting
Açar sözlər: valideynlər, ünsiyyət, manipulyasiya, yeniyetmə, yenidəntərbiyə

Yenidəntərbiyəyə ehtiyacı olan uşaq və yeniyetmələr böyüklərin onlara münasibətinin nəticəsi kimi meydana gəlirlər. Onların çoxusu ünsiyyət tələbatı ailədə, və təhsil aldığı məktəbdə təmin olunmayan yeniyetmələrdir. Çətin uşaqlar nadinc, sözə baxmayan, tənbəl, inadkar, intizamsız, kobud, yalançı, asosial olurlar. Yeniyetmə özünü pis aparırsa, pedaqoji təsirlərə laqeyd qalırsa, deməli onunla qarşı tərəflər arasında müəyyən anlaşılmazlıqlar yaranmışdır. Yenidəntərbiyəyə ehtiyacı olan uşaq və yeniyetmələrin meydanagəlmə səbəbləri belə bir qənaətə gəlməyə əsas verir ki, onları "düz yola" qaytarmaq üçün psixoprofilaktika və psixokorreksiya vasitələrindən faydalanmaq məqsədəuyğun olardı.

Mütəxəssislər yenidəntərbiyəyə ehtiyacı olan, başqa sözlə "çətin" yeniyetmələrin 4 qrupuna diqqət yetirirlər:

1) davranışındakı qüsurları onun iradi-emosional inkişaf səciyyəsi ilə şərtlənən yeniyetmə;

2) pedaqoji cəhətdən baxımsız və nəticədə əxlaqi təsəvvürlərə yiyələnməyən yeniyetmə;

3) əlverişli olmayan inkişaf şəraiti və ya tərbiyəçinin düzgün iş apara bilməməsinin təsiri ilə çətin böyüyən yeniyetmə;

4) uyğun gəlməyən münasibətlərlə şərtlənən və yaxud xüsusi çətin tərbiyə alanlar".

Valideynlər tərbiyəli, əxlaqlı, yüksək mənəviyyatlı, geniş dünyagörüşünə, savada, nümunəvi davranışa malik oğul və qızlar tərbiyələndirmək üçün övladlarını öyrənməli, onun imkanları, fərdi müxtəlifliyi, arzu və istəkləri, meyilləri, əyləncələri, dostlarının, yoldaşlarının kim olduğu ilə maraqlanmalı, müstəqilliyinin qarşısını almamalıdır. Valideynlər anlamalıdırlar ki, onlar öz övladlarına, "çətin" olan uşağına, yenidəntərbiyəyə ehtiyacı olan yeniyetməyə bu halında, məhz bu gün lazımdır. Belə çətin vəziyyətdən onu çıxarmaq üçün ata-ana müəyyən güzəştlərə də getməli, qarşılıqlı anlamanın yaranmasına, onun keçirdiyi yaşantılara bələd olmağa çalışmalıdır. Əks təqdirdə, ailədə qayğını, diqqəti görməyən, bunun əvəzində laqeydlik hiss edən yeniyetmə özünə dəstəyi kənar mühitdə axtarmalı olur. Bu "kənar mühit"in mənəvi-psixoloji atmosferinin necə olması isə, valideynə sirr kimi qalır.

Etiraf edilməlidir ki, yeniyetmələrin yenidəntərbiyəyə ehtiyacı olmasında uğursuz ailələrin günahı daha böyükdür. Belə ailələr öz günlərini problemləri ilə başa vurur, uşaq arxa plana keçir. Bəzən qayğı, nəvaziş nədir, uşaq müntəzəm döyülür, söyülür və s.

Başqa hallarla da qarşılaşmaq olur. Uğursuz ailədə qadın bir sıra hallarda məsləhətsiz, öz uşaqlarının problemləri ilə tək-tənha qalır. Yaxud müəllimlər, psixoloqlar, polis şöbələrinin yetkinlik yaşına çatmayanların işləri üzrə inspektorları, sosial işçilər, uğursuz ailələrlə, yaxud "çətin" yeniyetmələrlə işdə böyük çətinliklərdə rastlaşırlar. Belə hallarda uğursuz ailəni diqqətlə öyrənmək, uğursuzluğun səbəblərini araşdırmaq və onların aradan qaldırılması üçün birgə tədbirlər müəyyənləşdirmək məsləhətdir. Təbii ki, yenidəntərbiyəyə ehtiyacı olan yeniyetmə də diqqətdən kənarda qalmamalıdır.

Bu sahədə müvəffəqiyyətə nail olmaq üçün uğursuz ailənin müasir tipologiyasını təhlil etmək, davranışı və rəftar tərzi qüsurlu olan, cinayət xarakterli əməllərə meyil göstərən yeniyetmənin ailəsindəki uğursuzluğun tiplərini, yetkinlik yaşına çatmayanların diviant davranışının formalarını, həmin yeniyetmələrə psixoloji təsirin mexanizmini müəyyənləşdirmək vacibdir.

Uğursuz ailə dedikdə nə başa düşülməlidir? Bu, elə ailədir ki, uşaqların tərbiyəsi, təhsili, ilkin sosiallaşması üzrə özlərinin başlıca vəzifələrini yerinə yetirmir; öz övladlarına psixoloji zədə vurur, onları deviant davranışlı şəxslərə, cəmiyyətə zidd əməllərə qurşanan insanlar edirlər.

Uğursuz ailənin tipindən asılı olaraq və yetkinlik yaşına çatmayanların deviantlığının formalarını nəzərə alaraq, "çətin" yeniyetməyə psixoloji təsirin metodikaları kompleksini nəzərdən keçirmək, psixokorreksiya proqramları işləyib hazırlanmalıdır.

Yeniyetmənin davranışında kənaraçıxma hallarının səbəbi onun tərbiyəsindən irəli gəlir. Çox güman ki, nə vaxtsa onun tərbiyəsində səhvlərə yol verilmişdir. Bunu tədqiqatlar da göstərir.

Yeniyetmənin "çətin" olmasının bir sıra səbəbləri vardır. Səbəblər sırasında uğursuz ailə şəraiti özünəməxsus yer tutur. Burada heç də yalnız ailə tərbiyəsinin tərzindən (təzyiqə əsaslanan despotik tipdən, yaxud əksinə, sərbəst, uşağı qayğılardan və vəzifələrdən azad edən, uşaqların taleyinə biganə və etinasız münasibətə əsaslanan rəsmi, quru tərzdən, aksetik, yaxud zərif üslubdan) söhbət getmir.

Söhbət, bilavasitə uğursuzluqdan, bəzi ailələrdəki yaramaz münasibətlərdən, məişət və sosial özbaşınalıqdan, ixtilaf və nizamsızlığın hökm sürdüyü valideynlər arasında ardı-arası kəsilməyən mübahisələrin kök saldığı ailələrdən gedir. Ailə üzvləri arasında münasibətlərin bərbad hala düşməsi kimi hallara rast gəlinir. Kəsəsi, mövcud ədəbiyyatda göstərildiyi kimi, "çətin yeniyetmələr", hər şeydən əvvəl "çətin" valideynlərin övladlarıdır. Həm də uğursuz kateqoriyasına heç də yalnız bu ailələr aid edilmir. Ciddi narahatçılığı eyni zamanda zahirən uğurlu olan, evdə övladları üçün hər cür şərait və rahatlıq yaradılan ailələr doğurur. Burada uşaq və yeniyetmələr dəhşətli tənhalıqla yaşayırlar. Bu ailələrdə valideynlər öz yeniyetmə oğul və qızlarının mürəkkəb daxili dünyası ilə maraqlanmır, onların tələbatlarını, arzu, istək, həvəs və maraqlarını, meyillərini, hiss və həyəcanlarını öyrənməyə və anlamağa çalışmır, təşəbbüs göstərmirlər. Laqeydlik mühiti uşaqlarda son dərəcə dərin ümidsizlik yaradır ki, onları böyüklərlə, valideynlərilə, müəllimləri, ailənin digər yaşlı üzvləri, qohumları ilə səmimi, xoş və xeyirxah ünsiyyətdən məhrum edir.

Yeniyetmə şəxsiyyətinin öz formasını dəyişməsi, başqa sözlə, deformasiyaya uğraması aşağıdakı mərhələlərdən ibarətdir: onun mənəvi-ruhi-iradi mühitində boşluqlar və təhriflər baş vermiş, ona görə də bütün bu hallar onun davranış motivasiyasının bu yönümdə - xoşagəlməz baxışlar, bəyənilməyən rəftar, ünsiyyət və oturuş-duruş adətlərinin formalaşmasına imkan vermişdir. Adameşitməzlik, sözə, öyüd-nəsihətə qulaq asmamaq, öz bildiyini eləmək və bunu normal hesab etmək daha ciddi nəticələrə səbəb olur: yeniyetmə hüquq qaydalarını,

qanunun tələblərini pozur. Bu hal tez-tez təkrar olunur və o, cinayət yoluna düşür.

Yenidəntərbiyə yeniyetmə şəxsiyyətinin mənfi xüsusiyyətlərinin profilaktikasına və aradan qaldırılmasına xidmət edir və aşağıdakı kateqoriyalardan olan yeniyetmələri əhatə edir: 1) "çətin" tərbiyə olunan; 2) pedaqoji cəhətdən özbaşına buraxılmış; 3) hüquq qaydalarını pozan yetkinlik yaşına çatmamışlar; 4) yeniyetmə cinayətkarlar.

Yenidəntərbiyəyə ehtiyacı olan yeniyetmələrin deviant davranışının formalarına aiddir: təhsildən yayınmaq, istər valideynin, istərsə də müəllimin, sözünə baxmamaq, insanlarla, o cümlədən həmyaşıdları ilə kobud və rəhmsiz davranmaq, yüksək səviyyəli aqressivlik, tüfeylilik, avaraçılıq, erkən cinsi

həyata başlamaq, xuliqanlıq, oğurluq, narkotikə, spirtli içkilərə qurşanmaq, siqaret çəkmək, fahişəlik, kriminal qruplarda əlaqədə olmaq, vandalizm və s.

Daha çox fiziki və psixoloji cəhətdən sağlam olmayan yeniyetmələr deviant davranış nümayiş etdirirlər.

Pedaqoji və psixoloji ədəbiyyatda (A.İ.Uiyutikov, İ.S.Qanşina və b.) yenidəntərbiyəyə ehtiyacı olan yeniyetmənin tərbiyəsinə mənfi təsir göstərən uğursuz ailənin yeddi tipinə münasibət bildirilir:

1. Spirtli içkiyə aludə olan (qurşanan) ailə. Valideynlərdən biri, yaxud hər ikisi spirtli içkidən hədsiz istifadə edir.

2. Asosial və mənəviyyatca düşkün ailələr. Belə ailələr cəmiyyətə zidd yönəlmələrlə səciyyələnir.

3. Münaqişəli vəziyyətin hökm sürdüyü ailələr. Belə ailələrdə ya münaqişə daim baş alıb gedir, yaxud da ara-sıra olur. Nəticədə ailədə bir-birinə qarşı hörmətsizlik, təhqir, bir-birini söymə, ərin arvadını döyməsi şəraiti hökm sürür.

4. Kriminal ailələr. Burada valideynlərdən, böyük qardaşlardan (bacılardan), ailənin digər üzvlərində kişsə, yaxud kimlərsə ya həbsdədirlər, yaxud həbsdən azad olub gəliblər.

5. Valideynləri psixi cəhətdən xəstə olduqları ailələr. Ata-anadan biri, yaxud hər ikisi psixi dispanserdə qeydiyyatda dayanır. Bir sıra hallarda belə ailələrdən olan uşaqların da psixi cəhətdən müəyyən qüsurları olur. Onlar dərsdən yayınır, küçələrdə dolaşır və s.

6. Valideynin narkotik qəbul etdiyi ailə. Ata-analardan biri, yaxud hər ikisi narkotik qəbul edir.

Uğursuz ailənin yuxarıdakı təsnifatı uğursuz ailənin yenidəntərbiyəyə ehtiyacı olan yeniyetməyə təsirinin kriminigen xarakterini göstərir.

Beləliklə, uğursuz ailələrlə məqsədyönlü, sistemli, fasiləsiz iş aparılmalıdır ki, onların yeniyetmələrə təsirini neytrallaşdırmaq mümkün olsun. Pis təsir altında olan yeniyetmənin yenidəntərbiyəsi diqqət mərkəzində durmalı, bütün tərbiyə təsisatları yeniyetmənin həyatın fərəhli yollarına çıxmasına kömək göstərməlidirlər.

Ümummilli liderimiz Heydər Əliyevin sözləridir: "Bizim ailəmizdə böyük məsuliyyət və kiçik azadlıq var idi". Hər bir uşaq, hər bir yeniyetmə bu azadlığı hiss etməlidir, onun müstəqilliyini, təşəbbüsünü məhdudlaşdırmaq olmaz. Hər bir ata, hər bir ana çalışmalıdır ki, ailəsində "böyük məsuliyyət və kiçik azadlıq" hökm sürsün. Bu, yeniyetmələrin gələcəyi, firavan günləri üçün lazımdır.

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PSYCHOLOGICAL SCIENCES

MAİN DİRECTİONS AND MODERN APPROACHES OF PSYCHOLOGİCAL SCİENCE

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Abstract

The subject of pedagogical psychology is the study of the psychological regularities of human education. It studies the formation of thinking in students, studies the problems of managing the process of mastering the methods and habits of intellectual activity. It clarifies the factors affecting the success of the educational process, the mutual relations between the teacher and students and relations in the student collective, the individual-psychological differences of students, the psychological characteristics of educational work with children, cases of deviations from the norm that manifest themselves in mental development, etc.

Medical psychology studies the psychological aspects of the doctor's activity and the behavior of the patient. It is divided into neuropsychology, which studies the relationship of mental phenomena with physiological brain structures, psychopharmacology, which studies the effect of drugs on the mental activity of a person, psychotherapy, which studies and uses mental influence means for the treatment of patients, psychoprophylaxis, which works out a system of measures to ensure the mental health of people, and psychohygiene.

Keywords: psychological aspects, neuropsychology, behavior, effect

Legal psychology clarifies psychological issues related to the implementation of the legal system. It is divided into forensic psychology, which studies the psychological characteristics of the behavior of participants in the criminal process, criminal psychology, which deals with the psychological problems of the behavior and personality formation of the criminal, the motives of the crime, etc., and correctional psychology, which studies the psychology of the convict in a correctional labor colony, the psychological problems of upbringing using persuasion and coercion methods. Along with all this, one can also mention military psychology, sports psychology, commercial psychology, psychology of scientific creativity, and the psychology of artistic creativity.

If we accept the psychological aspects of development as the basis for classifying the branches of psychology, then a number of new areas appear before us in which the principle of development is implemented in its problems. As one of these, age psychology studies the age characteristics of mental processes, age opportunities for mastering knowledge, factors of personality development, etc. One of the central problems of age psychology is the problem of training and mental development, as well as their mutual dependence.

The psychology of abnormal development or special psychology is divided into pathopsychology, which studies deviations in the process of mental development, mental disorders in various forms of brain pathology, oligophrenic psychology - the science of the pathology of mental development associated with congenital defects of the brain, surdopsychology and typhlopsychology.

If we classify the branches of psychology in terms of psychological aspects of the relationship between personality and society, then we can also distinguish a number of areas of psychology that are combined with the concept of social psychology. In social psychology, three main problems are studied: group, communication and personality problems.

Each science uses research methods to study its object. Research method

means a set of methods and tools that science uses to study its subject.

Research methods in psychology are related to its methodology. In modern science, methodology is used in three senses:

1) General methodology;

2) Special methodology;

3) Methodology as a set of specific methodological methods.

General methodology refers to the "general philosophical approach, general method of cognition" that the researcher refers to. Specific methodology refers to the set of methodological principles applied in the relevant field of science. When considering methodology as a set of specific methodological methods, psychological research methods are usually clarified. Specific research methodology should be scientific in nature. Here, the criteria that determine the effectiveness of the research, namely the validity of the method, the reliability of the information, etc., should be taken into account. In specific psychological research methods, 4 stages are mainly distinguished.

1) Preparatory stage: at this stage, initial information is collected in various ways.

2) It is of an experimental nature. At this stage, the specific methodology of the research is implemented. That is, empirical facts are collected by applying various methods.

3) Research materials are analyzed quantitatively.

4) Materials are interpreted on the basis of psychological theory. Research methods in psychology are mainly divided into 4 groups.

The first group includes comparative, long-term and complex methods. They are called organizational methods.

The second most extensive group of methods consists of empirical methods of obtaining scientific materials, facts. These include: a) observation and self-observation, experimental methods, b) psychodiagnostic methods, c) methods of analyzing activity processes and products, biographical methods, etc.

The third group of methods includes methods of processing materials. These include:

1) quantitative (mathematical-statistical) analysis;

2) qualitative analysis.

The fourth group of methods is called interpretative methods. They consist of various variants of structural and genetic methods. With the help of these methods, the structure of the studied mental process, state or property is analyzed or the developmental characteristics at a certain age period are clarified. Psychology combines the data of these sciences and at the same time influences them, becoming a model of the sciences about man. Let us briefly look at the relationship of psychology with other sciences. It is impossible to understand the human psyche and behavior without knowledge of its natural and social existence. Therefore, the study of psychology requires the acquisition of knowledge about human biology, the structure and activity of its higher nervous system. Knowledge about the relationship between mental phenomena and the activity of the central nervous system has found its concrete reflection in the physiology of higher nervous activity. It is no coincidence that when talking about the natural scientific foundations of psychology, it is the laws of higher nervous activity that are referred to. Psychology is closely connected with the history and culture of society. Thus, in the development of higher mental functions in man, the main historical achievement of civilization, the tools of labor and the system of signs played a decisive role. Knowledge about the foundations of sociology also allows for a deep study of the human psyche and its understanding. The rapid development of social psychology confirms this once again. In modern times, social psychology penetrates all areas of human relations, allowing us to clarify how human social behavior is acquired through mental properties. Psychology has a serious kinship with the science of philosophy. This is no coincidence. As is known, psychology began to take shape within philosophy before it became an independent science. Undoubtedly, it would be impossible to determine and study the psychological "dimensions" of personality without referring to philosophical knowledge about man, his specific life conditions, perception of reality and activity. Consciousness, thinking and other mental phenomena are not given to people innately, ready-made. They are acquired in the process of training and upbringing of a person in ontogenesis (in the process of individual development). From this it becomes clear that psychology has a connection with the science of pedagogy. The main connection between the sciences of psychology and pedagogy is connected with the proximity of the subjects of these sciences. First of all, the object of these sciences is a developing person (child and elderly). On the other hand, psychology studies the laws of development of the human psyche. Pedagogy, on the other hand, develops the laws of management of personality development.

Human upbringing, education and training means the purposeful development of his psyche, thinking, and activity. One of the factors indicating the important mutual relationship between the sciences of psychology and pedagogy is the similarity in their research methods. Many scientific psychological searches can play the role of a tool for solving pedagogical problems. As a scientific discipline, psychological knowledge is used in pedagogy to explain, interpret, and systematize pedagogical facts. In modern times, a close relationship between psychology and linguistics has also begun to occupy a wide place. We see a clear manifestation of this in the emergence of psycholinguistics.

Psycholinguistics is a field of science that involves the complex study of speech behavior by psychologists and linguists. Compared to linguistics and the psychology of speech, psycholinguistics has its own independent subject of research. Psycholinguistics is more often considered "its own" by psychology. True, there is a field in psychology that has existed for a long time - the psychology of speech. The subject of speech psychology coincides with the object and subject of psycholinguistics. Therefore, these two disciplines are often confused with each other. Although there is a basis for such identification, there are also aspects that distinguish these two terms from each other. Their difference is mainly manifested in the subject of study. While psychology focuses its attention more on the characteristics of the mental functions of consciousness during the formation, understanding and formation of speech, psycholinguistics also tries to take into account the means of expression (verbal and non-verbal) of these functions in people's speech activity and speech behavior. Psycholinguistics is a relatively young science. It arose approximately in the late 50s and early 60s of the 20th century. The "father" of the Soviet psycholinguistics school was A.A. Leontyev. Psychology 16 Due to the expansion of the field of science, various areas of psycholinguistics have emerged. These include general psycholinguistics, special psycholinguistics, social psycholinguistics, and age psycholinguistics (ontolinguistics). The main fields of psychology. Psychology is a multidisciplinary science. In modern times, there are various fields of psychology that are developing relatively independently. That is why it would be more appropriate to use the term "psychological sciences" rather than "psychological science". Thus, every 4-5 years we witness the emergence of a new field of psychology. Various principles are used to classify the numerous fields of psychology. First of all, psychological disciplines can be classified as fundamental and applied, general and special. The fundamental or basic fields of psychology are fields aimed at interpreting psychology and human behavior in a way that everyone can understand, regardless of their identity and the field of activity they work in. These fields of psychology provide the same necessary information for all people interested in psychology and human behavior. Due to this universality, this field of psychology is used under

the name "general psychology". As for the applied areas of psychology, these include its areas directly applied to practice. The general areas of psychology pose and solve development problems that are equally important for all scientific directions without exception.

As for the special areas of psychology, it sets itself the goal of studying any one or several groups of phenomena. The following three principles are also used in the existing literature to classify modern psychological disciplines: 1. According to specific areas of activity; 2. According to psychological aspects of development; 3. According to the attitude of a person to society. Since it is impossible to cover all of these areas, let us briefly consider some of them that are directly related to education. The most fundamental area of psychological science is general psychology. General psychology or incorporates fundamental psychological knowledge. The global issues that general psychology is interested in and must solve, the questions it must answer are the following: What is the psyche? What are its structure and functions? What regularities does the psyche have in phylogenesis and ontogenesis? What are the levels of development of the psyche and according to what criteria can they be determined? What is the relationship between the psyche and the brain? What is the role of innate and acquired biological and social factors in mental development? What are the criteria that distinguish normal and abnormal development of the psyche? In addition to studying problems related to the psyche as a whole, general psychology is also engaged in the study of specific issues related to mental processes, mental states and properties. Since the main object of psychology is a person, general psychology primarily focuses on the investigation of issues related to his (a person's) personality, activity, communication with cognitive processes, system of relationships (feelings) and volitional activity, volitional regulation, studying them both theoretically and experimentally. From what has been said, it is clear that general psychology reflects generalized knowledge about mental phenomena that is of equal interest to everyone. By becoming familiar with this knowledge, every person can master the general secrets of psychology. Let us consider some of the special areas of psychology that are closely related to education, training and upbringing. One of the important special areas of psychology that is related to specific activities and has high practical importance is pedagogical psychology. Pedagogical psychology studies the psychological problems of training, upbringing and pedagogical activity. The most important problems that pedagogical psychology must solve are to reveal each sensitive period of children's lives and determine all the opportunities necessary for their development during that period, to reveal the mutual relationship between training and development, to clarify the general and age-related aspects of training and upbringing, their relationship, to investigate the psychological regularities that ensure the effectiveness of training and upbringing, etc. Another important area of psychology that is closely related to pedagogical psychology is age psychology. Age psychology studies the dynamics, regularities of mental development in a person from birth to the end of his life, the characteristics of the development of mental processes and properties of the personality in ontogenesis. Age psychology has such sections as child psychology, adolescent psychology, youth psychology, adult psychology, old age psychology, and longevity psychology (gerontopsychology). Differential psychology is one of the special fields of psychology. Differential psychology is a branch of psychology that studies, interprets, and explains the individual psychological and behavioral differences of people. The main method of differential psychology was tests. In the early periods, these tests were individual tests, then group tests appeared, and later projective tests were created and used. Genetic psychology can also be attributed to special fields of psychology. Genetic psychology studies the hereditary mechanism of psyche and behavior, their dependence on genotype. Age psychology, differential and genetic psychology together form the scientific basis for understanding the laws of mental development of a child. One of the areas of psychology that attracts the most attention in modern times is social psychology. Social psychology is a scientific field that studies the system of interpersonal relations in a certain social group in the process of joint activity and communication, the reflection of this system of relations in the psychology of the group as a whole, as well as of the individual. Such knowledge is necessary for the psychologically correct organization of education. Legal psychology, one of the important areas of psychology, considers the study of legal norms and rules of behavior by a person, clarifies psychological issues related to the implementation of the legal system. It has sections such as forensic psychology, criminal psychology, correctional psychology, etc. Medical psychology can be noted as one of the areas of modern psychology that has taken a special place. Medical psychology studies the psychological aspects of the doctor's activity and the patient's behavior, his hygiene, prevention, diagnostics, treatment, examination and rehabilitation. Medical psychology includes clinical psychology, pathopsychology, neuropsychology, somatopsychology, general medicine, psychiatry, psychoprophylaxis and psychohygiene, psychocorrection, etc. Pathopsychology, as well as psychotherapy, serves to work with people who have defects in their psyche and behavior. The main task of these areas of psychology is to identify the causes of the existing mental disorder and ways to eliminate it. renir. As for psychodiagnostics, which is one of the new areas of modern psychology, it deals with the theory and practice of assessing the developmental characteristics of people's mental properties, processes and actions with the help of scientifically verified methods that allow obtaining substantial information about them. In conclusion, it should be noted that we have briefly familiarized ourselves with only a part of modern psychology here. Sports psychology, labor psychology, art psychology, space psychology, management psychology, experimental psychology, ethnic psychology, etc. areas of psychology also have their own subjects and tasks. Undoubtedly, it is beyond the scope of this resource to provide detailed information about all of them here.

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TECHNICAL SCIENCES

A STUDY OF THE INFLUENCE OF TRAFFIC INTENSITY ON THE DETERMINATION OF THE LOCATION OF SERVICE FACILITIES IN THE ROADSIDE ZONE OF MOTOR ROADS

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ ИНТЕНСИВНОСТИ ДВИЖЕНИЯ НА ОПРЕДЕЛЕНИЕ МЕСТ РАСПОЛОЖЕНИЯ СЕРВИСНЫХ ОБЪЕКТОВ НА ПРИДОРОЖНОЙ ЗОНЕ АВТОДОРОГ

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Abstract
This article presents practical problems related to determining the required number of gas stations along highways. The Almaty–Ust-Kamenogorsk and Astana–Petropavlovsk highways are used as examples. This example allows for a more accurate determination of the required number and capacity of gas stations located along public highways.

Аннотация
В статье приведены практические задачи, связанные с определением потребного количества автозаправочных станций на притрассовой зоне автомобильных дорог. В качестве примера взяты автомобильные дороги «Алматы–Усть-Каменогорск» и «Астана–Петропавловск». Данный пример дает возможность более точно определить потребное количество и мощность АЗС, располагаемых в притрассовой зоне автомобильных дорог общего пользования.

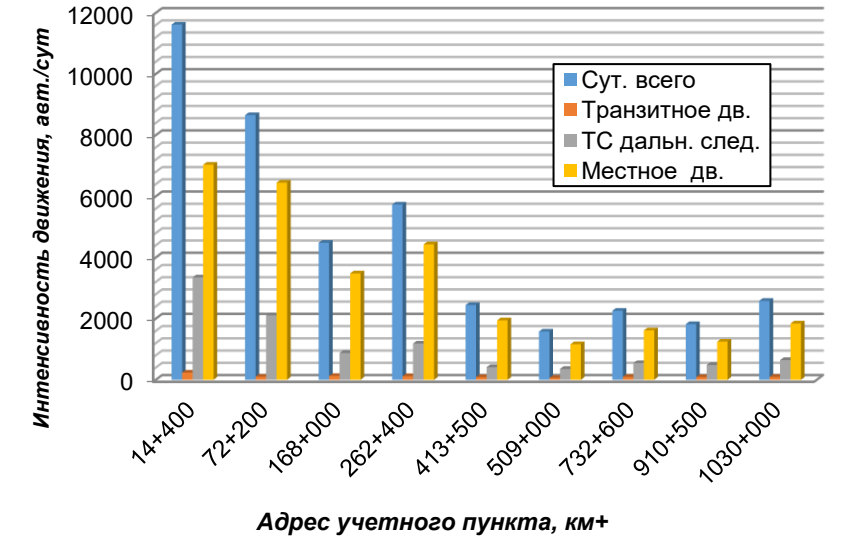
Keywords: highway petrol stations, service manager, diesel fuel, petrol, metering point, traffic intensity, traffic flow composition.
Ключевые слова: притрассовые автозаправочные станции, сервис-менеджер, дизельное топливо, бензин, учетный пункт, интенсивность движения, состав транспортного потока.

В настоящее время беспорядочно растет количество автозаправочных станций на притрассовой зоне автомобильных дорог общего пользования. Причем, до выбора места их расположения предпринимателями практически не проводится технико-экономическое обоснование, в результате которого существенно меняется режим движения на трассе либо они могут оказаться в экономически невыгодном месте. Поэтому, прежде чем выбрать место расположения АЗС и определить ее мощность, сервис-менеджер обязан провести предварительные исследования, связанные с изучением: экономического положения района, в котором пролегают данные автомобильные дороги и размещением производительных сил, наиболее крупных грузообразующих пунктов, дающих большие грузопотоки; наличия подъездов к железнодорожным станциям, существующих пересечений и примыканий местных дорог; размещения зон отдыха, дающих значительные пассажирские перевозки и населенных пунктов, расположенных в зоне влияния исследуемых участков автомобильных дорог [1].

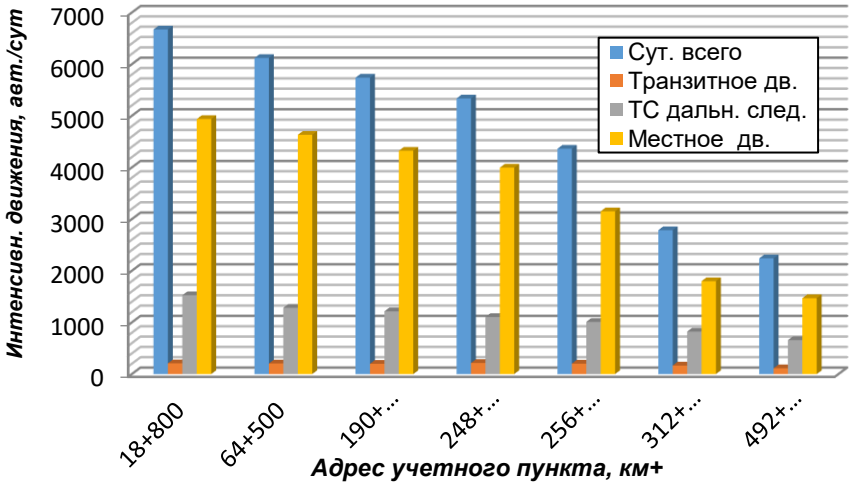
Выбор опытных участков. Для обоснования в полевых условиях места расположения автозаправочных станций (АЗС) и определения их оптимального расстояния выбирались опытные участки. В качестве опытного участка были выбраны участки автомобильных дорог «Астана–Петропавловск» и «Алматы–Усть-Каменогорск». Дальность поездки от Петропавловска до Астаны по карте автомобильных дорог составляет 502 км и при этом расчетное время пути 5 ч. 49 мин, а от Алматы до Усть-Каменогорск – 1087 км, продолжительность поездки без учета ночлега – 16 ч. 55 мин. При этом, на этих опытных дорогах подсчет интенсивности движения и определение состава транспортного потока осуществлялись в соответствии с методическими положениями [2]. При выборе учетных пунктов учи-

тывалось расположение населенных пунктов, находящихся в притрассовой зоне исследуемой дороги и места расположения существующих сервисных объектов.

Результаты подсчета интенсивности движения. На рисунке 1 приведены результаты подсчета интенсивности движения на учетных участках автомобильной дороги «Астана–Петропавловск» и «Алматы–Усть-Каменогорск», выполненные 25-28 августа 2025 года.



а)



б)

а – «Алматы–Усть-Каменогорск»; б – «Астана–Петропавловск»
Рис. 1. Интенсивность движения транспортных средств на учетных пунктах автомобильной дороги

При подсчете интенсивности движения и определении состава транспортного потока по видам транспортных средств, относящихся к международным транспортным средствам, транспортным средствам дальнего следования внутри страны и к местным транспортным средствам, учитывались номерные знаки этих транспортных средств. Например, к международным транспортным средствам относились все виды транспорта, номерные знаки которых не соответствуют казахстанским индексам, к транспортным средствам (ТС) дальнего следования внутри страны относятся те ТС, номерные знаки которых не соответствуют индексам данной области.

При анализе полученных результатов полевых исследований, выяснилось, что уровень интенсивности движения и состав транспортного потока на исследуемых дорогах находятся в своеобразной корреляции. Например, общая интенсивность движения, включая международные ТС, ТС дальнего следования внутри страны и местного движения, на участках автомобильной дороги «Астана–Петропавловск» составляет от 6867 (выход из г. Астаны) до 2786 (вход в г. Петропавловск). При этом общее количество международных транспортных средств составляет от 207 автомобилей (км 18-800) до 113 автомобилей, т.е. спад составляет в 1,83 раз, количество ТС дальнего следования внутри страны от

1526 до 657 автомобилей (спад в 2,32 раз) и местные транспортные средства от 4938 до 1470 (спад в 3,60 раз) автомобилей соответственно. Как видно, уровень движения ближе к Астане гораздо выше, чем к Петропавловску. Причем, спад международных рейсов значительно ниже, чем местных (в 1,97 раза) и транспортных средств дальнего следования (в 1,27 раза).

Изменение состава транспортного потока по видам транспортных средств на учетных пунктах также не равномерное. Например, на участке км 18+800 (выход из г. Астаны) количество легковых автомобилей в потоке составляет 5234 (78,46 %) автомобилей, автобусы – 104 (1,56 %), 2-х осные грузовые автомобили – 333 (4,99 %), 3-4 осные грузовые автомобили – 322 (4,83 %), автопоезда – 307 (4,60 %) и седельные тягачи с полуприцепами – 340 (5,10 %) и прочие транспортные средства – 31 (0,46 %) (рисунок 3 а). Сравнительные результаты других участков представлены в таблице 1.

Если сравнить аналогичных показаний, т.е. состава транспортного потока на выходе из г. Алматы в сторону Усть-Каменогорск, то можно увидеть следующее: количество легковых автомобилей в общем потоке составляет 10321 (88,87 %) автомобилей. По сравнению с выходом из г. Астаны почти в двое больше, т.е. на 5087 автомобилей, автобусы – 229 (1,97 %), 2-х осные грузовые автомобили – 378 (3,25 %), 3-4 осные грузовые автомобили – 182 (1,57 %), автопоезда – 231 (1,99 %) и седельные тягачи с полуприцепами – 249 (2,14 %) и прочие виды транспорта – 24 (0,21 %).

Расход топлива зависит от конструктивных и эксплуатационных факторов дороги. К эксплуатационным факторам относится средняя техническая скорость, масса перевозимого груза и суммарное сопротивление транспортно-эксплуатационных состояний дороги (коэффициент сцепления, ровность, различные виды деформаций и т.д.) [3]. Например, при движении автомобиля по скользкой дороге значение коэффициента сцепления по сравнению с чистым, сухим асфальтобетонным покрытием снижается до 10-15 раз, при этом расход топлива увеличивается на 30-40 %. На снижение скорости движения транспортных средств существенное влияние оказывают различные виды дорожных деформаций.

Исходные данные: Средняя потребность топлива для легковых автомобилей, двигающихся по горизонтальному участку, принимаем равным 16 л/100 км, а на пересеченной местности этот показатель может подниматься до 20 л на 100 км и выше. Другие показатели расчета приведены в таблице 1.

Таблица 1

Потребность топлива по видам транспортных средств на участках автомобильных дорог Республики Казахстан

Расстояние между учетными пунктами, км		Легковые автомобили и микроавтобусы	Автобусы		Одиночные грузовики			Автопоезда	Седельные тягачи с полуприцепом	ВСЕГО, общее по участкам удельное на 100 км	
			средние	тяжелые	2-х осные, грузоподъемностью, т		3-4-х осные гр-тью, т			Бензиновые	Дизельные
					до 2	Свыше 2-х					
1		2	3	4	5	6	7	8	9	10	11
Автомобильная дорога «Астана–Петропавловск), км 18.8–492,0											
18,8–64,5 45,7		5234 (16) 38271,0	41 (17,9) 335,4	63 (26,5) 763,0	140 (18,1) 1158,0	193 (22,4) 1975,7	322 (28,4) 4179,2	307 (32,2) 4517,6	340 (31,7) 4925,5	39764,4 87011,8	16361,0 35800,8
64,5–190,2 125,7		4751 (16) 95 552,1	37 /17,9) 832,5	57 (26,5) 1898,7	112 (18,1) 2548,2	214 (22,4) 6025,6	312 (28,4) 11138,0	312 (32,2) 12628,3	297 (31,7) 11834,5	98932,8 78705,5	43525,1 34626,2
190,2–248,0 57,8		4454 (16,8) 41005,3	39 (19,2) 432,8	50 (28,8) 832,3	109 (19,4) 1222,2	208 (23,5) 2825,3	274 (29,6) 4687,8	291 (34,1) 5735,6	266 (32,9) 5058,3	42660,3 80727,2	19139,3 33113,0
248,0–256,5 8,5		4159 (16) 5656,2	31 (17,9) 47,2	43 (26,5) 96,9	95 (18,1) 146,2	228 (22,4) 434,1	252 (28,4) 634,0	259 (32,2) 708,9	260 (31,7) 700,6	5849,6 68818,8	2574,5 30288,2
256,2–312,8 56,6		3422 (16) 30989,6	27 (17,9) 273,5	36 (26,5) 540,0	67 (18,1) 686,4	156 (22,4) 1977,8	209 (28,4) 3359,5	214 (32,2) 3900.2	228 (31,7) 4090,8	31949,5 56447,9	13868,3 24502,3
312,8–492,0 179,2		2134 (17,4) 66539,8	9 (20,4) 329,0	19 (30,1) 1024,8	37 (20,1) 1332,7	79 (24,6) 3482,6	136 (30,1) 7335,7	172 (36,31) 11191,6	183 (35,4) 11608,9	68201,5 38058,9	34643,6 19332,4
Всего, л	**Бензин**	**278 014,0**	**2250,4**		**7093,7**					**287358,1**	
	Дизтопливо			**5155,7**		**16721,1**	**31334,2**	**38682,2**	**38218.6**		**130111,8**
Удельная потребность на 100 км дороги		**58 714,7**	**475,3**	**1088,8**	**1498,1**	**3531,4**	**6617,6**	**8169,4**	**8071,5**	**60688,1**	**27478,7**

Продолжение таблицы 1

1	2	3	4	5	6	7	8	9	10	11
Автомобильная дорога «Алматы–Усть-Каменогорск), км 11,4–1030,0										
11,4–72,2 60,8	10321 (16) 100402,7	43 (17,9) 468,0	186 (26,5) 2996,8	104 (18,1) 1144,5	274 (22,4) 3731,7	182 (28,4) 3142,6	231 (32,2) 4522,4	249 (31,7) 4799,1	102015,2 167788,2	19192,6 31566,8
72,2–168,0 95,8	7771 (16,5) 122836,2	29 (18,3) 508,4	59 (27,3) 1543,1	96 (19,2) 1765,8	210 (23,7) 4768,0	142 (29,7) 4040,3	171 (33,8) 5537,0	156 (33,0) 4931,8	125110,4 130595,4	20820,2 21733,0
168,0–262,4 94,4	3956 (18,9) 70581,4	12 (21,2) 240,2	39 (30,2) 1111,8	43 (22,6) 917,4	133 (27,6) 3465,2	68 (33,4) 2144,0	119 (36,9) 4145,2	98 (36,2) 3348,9	71739,0 75994,7	14215,1 15058,4
262,4–413,2 150,8	4943 (18,3) 136409,0	19 (20,8) 596,0	60 (29,4) 2660,1	99 (22,0) 3284,4	175 (25,7) 6782,2	101 (32,7) 4980,5	154 (36,1) 8383,6	165 (35,8) 8907,8	140289,4 93030,1	31714,2 21030,6
413,5–509,5 96,0	2043 (17,1) 33537,9	12 (18,9) 217,7	33 (28,6) 906,0	31 (19,3) 574,4	68 (24,1) 1573,2	41 (30,9) 1216,2	85 (34,2) 2790,7	121 (34,3) 3984,3	34330,0 35760,4	10470,4 10906,7
509,5–732,6 223,1	1211 (16,5) 44578,7	8 (18,3) 326,6	29 (27,3) 1766,3	25 (18,9) 1054,1	71 (23,2) 3674,9	30 (29,7) 1987,8	68 (33,8) 5127,7	109 (33,5) 8146,5	45959,4 20600,4	20703,2 9279,8
732,6–910,5 177,9	1762 (17,7) 55482,4	13 (20,4) 471,8	24 (29,7) 1268,1	31 (22,2) 1224,3	86 (25,0) 3824,9	49 (31,5) 2745,9	108 (35,4) 6801,5	144 (35,2) 9017,4	57178,5 32140,8	23657,8 13298,4
910,5–1030,0 119,5	1388 (17,3) 28694,8	10 (19,1) 228,2	15 (29,2) 523,4	26 (21,7) 674,2	76 (24,5) 2225,1	53 (30,1) 1906,4	93 (34,7) 3856,4	152 (34,7) 6302,9	29597,2 24829,9	14814,2 12396,8
Бензин	**592523,1**	**3056,9**		**10639,1**					**606219,1**	
Дизтопливо			**12775,6**		**30045,2**	**22163,7**	**41164,5**	**49438,7**		**155587,7**
Удельная потребность на 100 км дороги	**58187,5**	**300,2**	**1254,6**	**1044,8**	**2950,5**	**2176,5**	**4042,5**	**4855,0**	**58187,5**	

При расчете учитывались состав транспортного потока, рельеф местности, погодно-климатические факторы и эксплуатационное состояние дороги. На рисунке 2 представлено место расположения существующих ( ) и несуществующих ( ) АЗС.

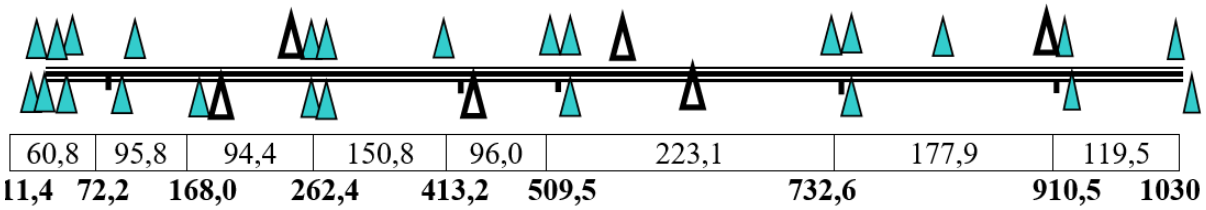
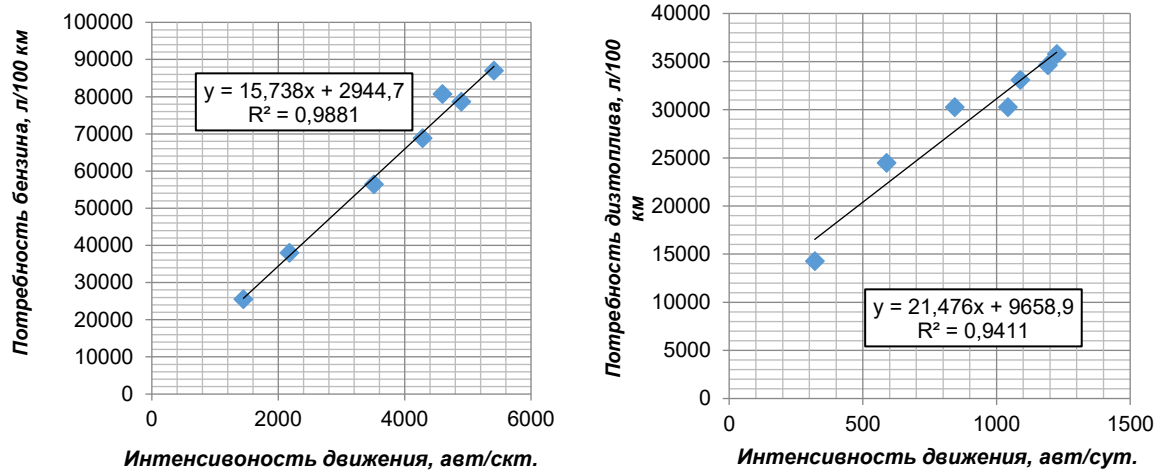


Рис. 2. Суточная потребность топлива по автомобильной дороге «Алматы–Усть-Каменогорск»

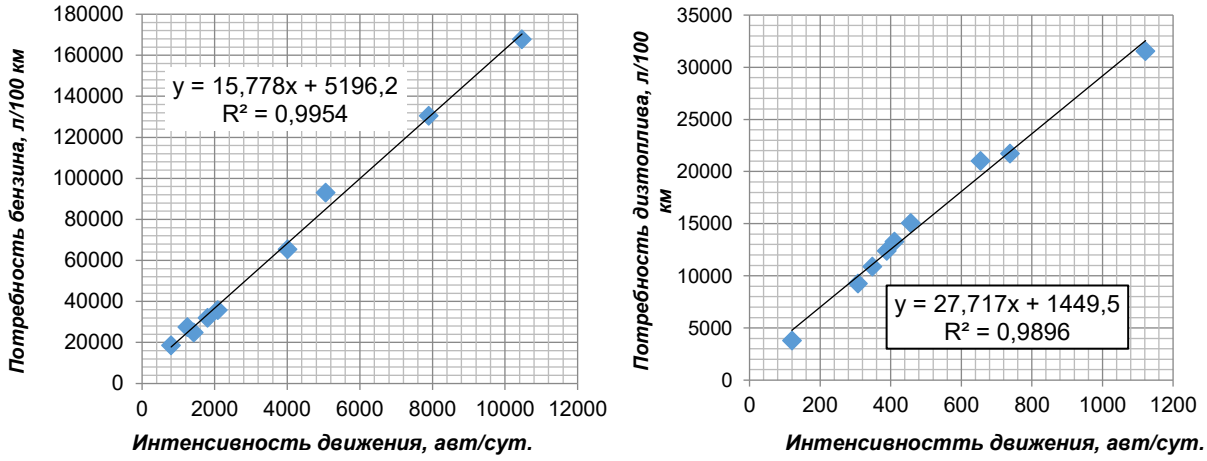
На рисунках 3 и 4 приведены результаты расчета по определению потребности суточного количества топлива на автодорогах «Астана–Петропавловск» и «Алматы–Усть-Каменогорск». Как видите, расход топлива по участкам в основном зависит от интенсивности движения и длины участка. Например, на участке автодороги «Алматы–Усть-Каменогорск», протяженность которого составляет 60,8 км, а общая интенсивность движения – 11614 авт./сут., суммарное количество потребности бензина на этом экономическом перегоне – 102015,2 л, а дизельных – 19192,6 л. При таком составе удельная потребность бензина на 100 км дороги составляет 167788,2 литров, а дизтоплива – 31566 литров.



а) *б)*

а – потребность бензина; б – потребность диз.топлива

Рис. 3. Корреляционная зависимость между суточной интенсивностью движения и общей потребностью топлива на 100 км дороги «Астана–Петропавловск



а) *б)*

а – потребность бензина; б – потребность диз.топлива

Рис. 4. Корреляционная зависимость между суточной интенсивностью движения и общей потребностью топлива на 100 км автодороги «Алматы–Усть-Каменогорск»

Оптимальное расположение автозаправочных станций тесно связано с интенсивностью движения и составом транспортного потока. Транспортный поток является техническим индикатором для определения количества дизельных и бензиновых топлив, а климатические факторы являются индикаторами определения объема дизельных топлив по их маркам.

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